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Fertility and mortality life-tables of an aphidophagous ladybird beetle, *Coccinella septempunctata* Linnaeus

Shefali Srivastava and Omkar*

Department of Zoology, University of Lucknow, Lucknow 226007, Uttar Pradesh, India
Email: omkaar55@hotmail.com

ABSTRACT: An aphidophagous ladybird beetle, *Coccinella septempunctata* Linnaeus was reared for four generations in the laboratory at temperature 25 ± 2 °C, R. H. 60 ± 5% and photoperiod 12L: 12D on aphid species *Rhopalosiphum maidis, Aphis gossypii, Aphis craccivora* and *Lipaphis erysimi* and thereafter fertility- and mortality life-tables were constructed. The net reproductive rate, intrinsic rate of increase and finite rate of increase was highest in fourth generation and lowest in first generation, whereas the doubling time and generation time was lowest in fourth generation and highest in first generation. The highest mortalities in egg, first, second, third, fourth instar and pupa, were recorded during first generation and the lowest during fourth generation. The overall per cent mortality prior to adult stage and trend index was highest in first generation and lowest in fourth generation. Total mortality value (Kappa value) was highest (0.5814) in first generation and lowest (0.2980) in fourth generation. First instar faced maximum mortality in the immature stages.
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KEYWORDS: *Coccinella septempunctata,* ladybird beetle, aphid, fertility life-table, mortality life-table, intrinsic rate of increase, biocontrol

INTRODUCTION

The investigations on fertility and mortality based life-tables are appropriate to evaluate the dynamics of animal populations. Life-table is a process of estimating attributes related to population growth potential as it follows the fate of a cohort of individuals from birth to death. Life- and fertility-tables are powerful tools for analyzing and understanding the impact of external factors upon the growth, survival, reproduction and rate of increase of an insect population (Bellows *et al.*, 1992). These studies are helpful in identifying (i) trend followed by successive generations,

*Corresponding author

(ii) understanding vulnerable life stages, (iii) trend of field mortality of pests/their natural enemies, (iv) periodicity of their occurrence, (v) mortality factors in nature, and (vi) the suitable conditions for mass rearing of a species.

Earlier, data on fertility and mortality life tables of many insect species have been used to improve rearing techniques as well as to assess the most suitable food sources and conditions (Fouly et al., 1995; Valicente and O'Neil, 1995; Souissi and Le Ru, 1997). The examples of practical use of life tables are abundant in literature (Elliot et al., 1988; Kieckhefer and Elliott, 1989; Michles and Behle, 1989). In order for mass rearing and augmentative release of natural enemies to become viable as an alternative to pesticides and other pest control measures, it must prove to be cost effective with large number of beneficial insects available upon demand. Fertility life-tables of many species of insects have also been used to improve rearing techniques by evaluating difference in reproductive rate, number of females per female within a generation (Birch, 1948) and intrinsic rate of increase, a constant value used to determine the population increase in an unlimited environment, especially based on the birth rate and death rate (Birch, 1948) when provided with different food supplies.

Coccinella septempunctata Linnaeus is an eurytopic ladybird beetle, predaceous on a number of phytophagous pests such as, aphids, mealy bugs, mites and scale-insects (Hodek and Honek, 1996). Because of its large size and voracious appetite, it is considered as a potent candidate for sustainable biocontrol programmes (Omkar and Srivastava, 2001). A perusal of literature revealed numerous studies on the various aspects of *C. septempunctata* with very poor account on life-tables. Earlier, Obrycki et al. (1997) constructed a partial life-table from first, second, and third instars of *Coleomegilla maculata* de Geer and *C. septempunctata*. Keeping in view these accounts, in the present study an attempt has been made to rear four generations of *C. septempunctata* on different prey species and constructing fertility and mortality-life tables with the objective to understand life-table characteristics, such as net fecundity rate, intrinsic rate of increase, finite rate of increase, generation time, doubling time, mortality of different stages, kappa values of mortality, key stage, sex ratio, generation survival and trend index, of *C. septempunctata* on different food supply.

MATERIALS AND METHODS

Stock maintenance

The adults of *C. septempunctata* were collected from the agricultural fields adjoining the city of Lucknow, India, and brought to the laboratory where the stock culture was maintained at $25 \pm 2\,°C$ temperature and $60 \pm 5\%$ R. H. Mating pairs were kept in glass beakers (11.0 cm height and 7.00 cm diameter) covered with fine muslin cloths that were fastened with rubber bands. The ladybeetles were fed on locally abundant aphid preys. The left over aphids and dried twigs were daily replaced with fresh ones to avoid contamination. The eggs were collected daily and the emerging instars reared.

Fertility life-table

For the formulation of fertility life-table for first generation, ten pairs of newly emerged male and female of *C. septempunctata* were taken from the stock culture in September–October and were placed in a Petri dish (diameter 15.00 cm height 8.5 cm) along with aphid prey, *Rhopalosiphum maidis* Fitch. Reproductive responses of these pairs were recorded. The pre-oviposition period, oviposition period, oviposition, and lifetime fecundity (total number of eggs laid by each female during her lifetime) was recorded. Number of females emerging from the total fecundity was recorded for the calculation of various demographic parameters. On the basis of obtained data, the demographic parameters of fertility life-tables were calculated from the formulae suggested by Birch (1948).

Net productive rate $(R_0) = \sum l_x m_x$

Mean generation time $(T_c) = \dfrac{\sum l_x m_x}{R_0}$

where

$x = $ Pivotal age

$L_x = $ Number of females surviving in a given proportion and

$m_x = $ Net fecundity of an emerging female

Intrinsic rate of increase $(r_m) = I_n R_0 / T_c$

The finite rate of increase $(\lambda_m) = $ antilog$_e - r_m$,

where

$e = 2.718228$

Generation time (GT) $= \ln R_0 / r_m$

Doubling time (DT) $= \ln 2 / r_m$.

Similarly, second generation was reared on *Aphis gossypii* Glover, third generation on *Aphis craccivora* Koch and fourth generation on *Lipaphis erysimi* (Kalt.) and the calculation of fertility life tables were made.

Mortality life-table

For the construction of a first generation mortality life-table, four hundred eggs of *C. septempunctata* were taken from the eggs laid by the females of first generation and kept in Petri dishes and observed for hatching. First instars were placed in groups of five in small glass beakers (11.0 cm height and 7.0 cm diameter) to avoid cannibalism and *R. maidis* was provided in sufficient quantity for consumption. The aphids were changed after every 24 hours, till the first instar moulted into second instar. The surviving second instars were transferred into new glass beakers. The same procedure was followed for the third and fourth instars and pupal stage of ladybird. Total developmental period, juvenile survival, juvenile mortality (*viz.*, eggs, larvae and pupae) as well as the sex ratio of the emerging adults were recorded and the data computed.

Following observations and calculations were made as suggested by Morris and Miller (1954).

x	=	The age interval, *i.e.* eggs, larvae, pupae and adults,
lx	=	The number surviving at beginning stage,
dx	=	The number dying within age interval x,
$100qx$	=	Apparent mortality, dx as % of lx,
$100rx$	=	Real mortality, dx as a % of the original cohort size,
k	=	A dimensionless measure of the mortality within age interval of x,
Sx	=	Survival rate of a stage,
K (Kappa)	=	The total of k values.

Regression analysis of k against K was done to evaluate the influence of former on the latter. Generation survival values and trend indices were also calculated (Harcourt, 1969).

$$\text{Generation survival} = \frac{\text{Number of female beetles}}{\text{Initial number of eggs}}$$

$$\text{Trend index} = \frac{\text{Number of eggs in the new generation}}{\text{Number of eggs in the old generation}}$$

Similar procedure was followed for other generations and calculations of mortality life-table were made.

<div align="center">RESULTS</div>

Fertility life-table

The data on fertility based demographic parameters revealed that the net reproductive rate (R_0) intrinsic rate of natural increase (r_m), and finite rate of increase (λ_m) was highest (681.26, 0.21 day^{-1}, 1.23 day^{-1}, respectively) during fourth generation and was lowest 206.79, 0.14 day^{-1}, 1.15 day^{-1} respectively) during first generation (Table 1). The generation and doubling times were however lowest (31.26 and 3.32 days, respectively) during fourth generation and highest (37.94 and 4.93 days, respectively) during first generation. Thus, *C. septempunctata* had the highest reproductive output with the shortest generation and doubling time in fourth generation.

Mortality life-table

Mortality prior to adult stage was maximum (74.25%) in the first generation and minimum (49.76%) in the fourth generation. The overall per cent mortality values were highest in the first instar and lowest in fourth instar during all the generations (Table 2). The highest egg mortality occurred in the first generation (15.00%) and lowest in fourth generation (7.36%). The mortality of all the instars was highest during first generation and lowest during the fourth generation. Real mortality values of all

TABLE 1. Demographic parameters of *Coccinella septempunctata* fed on aphids for four generations. The parameters are R_0: net reproductive rate; r_m: intrinsic rate of increase (day^{-1}); λ: the finite rate of increase: GT: the mean generation time (days); DT: doubling time (days)

	1st generation	IInd generation	IIIrd generation	IVth generation
R_0	206.79	289.95	407.55	681.26
r_m	0.14	0.17	0.17	0.21
λ	1.15	1.19	1.19	1.23
GT	37.94	33.14	34.75	31.26
DT	4.93	4.05	4.00	3.32

TABLE 2. A comparison of juvenile mortality, sex ratios, trend index and generation survival during different generations

	Generation			
	I	II	III	IV
Age interval	(%)	(%)	(%)	(%)
Per cent mortality in first instar	47.47	45.65	47.33	50.42
Per cent mortality in second instar	23.50	22.10	22.00	20.83
Per cent mortality in third instar	17.97	18.11	19.66	18.75
Per cent mortality in fourth instar	11.06	14.13	11.00	10.00
Per cent mortality prior to adult stage	74.25	72.40	67.53	49.76
Sex ratio	0.56	0.55	0.57	0.75
Trend index	1.25	1.16	1.07	–
Generation survival	0.15	0.15	0.19	0.29

the stages were highest in first generation and lowest in the fourth generation. Real mortality values of first instars were highest amongst the immature stages of the *C. septempunctata* in all the generations (Table 3).

Mortality values of different stages successively decreased from first to fourth generations. The total mortality values (K-value) decreased from 0.5814 to 0.2980 from first to fourth generation (Table 4). Correlation analysis (Table 5) revealed significant positive correlation (0.9981) between k values for first instar and the total K value.

Highest mortality in the first instars of all the generation indicates that this stage contributes most to the fluctuation in the population of the *C. septempunctata*, thus it is the key stage of each generation.

Sex-ratio, generation survival, trend index

The sex ratios (proportion of females in the population) were highest (0.75) in the fourth generation and lowest (0.55) in the second generation. The trend index

TABLE 3. Life-table of *C. septempunctata* for four generations

Generation		Eggs	Eggs hatched	First instar	Second instar	Third instar	Fourth instar	Pupae	Emergence	Male
						Age interval X				
First	lx	400	340	340	237	186	147	123	103	45
	dx	60	00	103	51	39	24	20		
	$100dx$	15.00	0.00	30.29	21.51	20.96	16.33	16.26		
	$100rx$	15.00	0.00	25.77	12.75	9.75	6.00	5.00		
	Sx	0.85	1.00	0.70	0.78	0.79	0.84	0.84		
Second	lx	500	435	435	309	248	198	159	138	62
	dx	65	00	126	61	50	39	29		
	$100qx$	13.00	0.00	28.96	19.74	20.16	19.69	13.90		
	$100rx$	13.00	0.00	25.22	12.20	10.00	7.80	5.80		
	Sx	0.87	1.00	0.71	0.80	0.79	0.80	0.87		
Third	lx	582	514	514	372	306	247	214	189	81
	Dx	68	00	142	66	59	33	25		
	$100qx$	11.68	0.00	27.63	17.74	19.29	13.36	11.68		
	$100rx$	11.68	0.00	24.39	11.34	10.14	5.67	4.29		
	Sx	0.88	1.00	0.73	0.82	0.81	0.87	0.88		
Fourth	lx	625	579	579	458	408	363	339	314	179
	dx	46	00	121	50	45	24	25		
	$100qx$	7.36	0.00	20.89	10.91	11.02	6.61	7.37		
	$100rx$	7.36	0.00	19.36	8.00	7.20	3.84	4.00		
	Sx	0.93	1.00	0.79	0.89	0.89	0.93	0.93		

TABLE 4. Population budget of *C. septempunctata* four generations

Stage	\kappa-values of different life-stages of *C. septempunctata* during different generations			
	I	II	III	IV
Egg	0.0705	0.0604	0.0555	0.0315
First instar	0.1549	0.1487	0.1366	0.1023
Second instar	0.1023	0.0969	0.0862	0.0506
Third instar	0.1023	0.1023	0.0915	0.0506
Fourth instar	0.0757	0.0969	0.0604	0.0315
Pupa	0.0757	0.0605	0.0555	0.0315
Kappa-value	0.5814	0.5656	0.4887	0.2980

decreased from 1.25 to 0.80 from first-to fourth generation, which revealed the high survival of their subsequent generations. The values of generation survival were highest (0.29) during fourth generation and lowest (0.15) during first and second generations (Table 2).

TABLE 5. Relationship between mortality
($k's$) stage wise and total mortality value
(Kappa) of *C. septempunctata*

Predatory stage	Correlation coefficient (r^2)
Egg	0.9706
First instar	0.9981
Second instar	0.9889
Third instar	0.9802
Fourth instar	0.9103
Pupa	0.6121

DISCUSSION

Net reproductive rate reveals the rate of multiplication in a generation (Lotka, 1945). For four successive generation of *C. septempunctata*, the net reproductive rate increased with increase in number of generations. The female laid high proportion of eggs with maximum number of females surviving during fourth generation. This cumulatively enhanced the net reproductive rate, as it is the summation product of survival of females and net reproductivity. A certain minimum value of intrinsic rate of increase is essential for survival in a particular environment. If the intrinsic rate of increase is less than this, it may lead to a struggle for existence. Evolution may operate to select species with an intrinsic rate of increase large enough to enable them to compete successfully with other species (Elliot *et al.*, 1988). The highest reproductive rate and intrinsic rate of natural increase in the fourth generation provided with *L. erysimi* as prey suggests it to be the more nutritious prey suitable for the mass rearing of *C. septempunctata* with reduced cost of rearing.

The generation time (GT) is the time between the birth of parents and the birth of the progeny; with supply of more nutritions prey causing a reduction in the generation time. Both the reproductive rate and generation time of *C. septempunctata* were negatively impacted by the supply of poor quality of prey leading to a lower intrinsic rate of increase and longer doubling time, indicating the relative unsuitability of prey during first and second generations. The predatory fitness of an adult insect predator depends mainly on the future trends in resource availability throughout the period of development of its larvae. The longer the developmental time of the predatory species, the smaller the degree of depletion of the prey patch by the predator. Therefore, relative efficiency of a predator as biocontrol agent is negatively correlated with generation time relative to that of prey.

The highest larval mortality in the first instar during all four generations is probably because of its being more sensitive to natural abiotic and biotic factors such as, attack by parasitoids/pathogens because of its soft cuticle and small size. There is also a tendency of instars to cannibalize the soft-bodied siblings even in the present of adequate food supply, especially during the early instars (Shands *et al.*, 1970).

The decrease in the larval and pupal mortality from first to fourth generation may be due to change in the food supply to *C. septempunctata*. The available prey during third and fourth generations were *A. craccivora* and *L. erysimi*, which were probably most suitable for *C. septempunctata*. The increased immature survival and other responses indicate the better and suitable nutrients of these prey for *C. septempunctata*. The prey species, *L. erysimi* and *A. craccivora* were earlier reported as most suitable prey for the *C. septempunctata* (Omkar and Srivastava, 2003).

The stages of ladybirds were subject to various mortality factors. Mortality in the egg stage was mostly due to infertility, cannibalism and certain factors that could not be identified. The decreased per cent mortality in the older instars and the pupal stage was possibly due to their thick cuticle, which provides them increased resistance to both abiotic and biotic factors. Pupal case is relatively hard and probably protects the stage from heavy mortality.

Heavy mortality during first and second generations and low mortality during third and fourth generations took place although utmost care had been taken to minimize cannibalism and attack of the parasitoids. This might be due to the difference in the nutritional quality of the prey supplied during different generations. Mortality caused by various factors was not always measurable. Various mortality factors operated during the laboratory rearing of *C. septempunctata* and synergistically caused mortality of different stages of the *C. septempunctata*. The attacks by the parasitoid, *T. coccinellae* was earlier identified as a cause of mortality for the larval and pupal stages of *C. septempunctata* (Omkar and Srivastava, 2002). Besides *T. coccinellae* certain other parasitoids and pathogens, like *Perilitus coccinellae* (Schrank) and *Beauveria bassiana* (Balsamo) were also known to be responsible for mortality of *C. septempunctata* (Puttarrudriah and Basavanna, 1953; Schaefer and Semyanov, 1992; Hye Jeong *et al.*, 1996; Geoghegan *et al.*, 1997). Amongst other possibilities of regulation of the mortality of different life stages during different generations are the changes in the abiotic conditions.

Low generation survival during first generation of *C. septempunctata* suggests that mortality factors operating in this generation reduced the population size and the high trend index indicates the next generation to be better than the present. Sex ratio, *i.e.* the proportion of females in the population, was highest during fourth generation and lowest during second generation, which revealed the probable role of prey species in sex ratio and it can be said that prey provided to adult *C. septempunctata* affected the sex of the progeny. Earlier it was found that when *C. septempunctata* were fed on alfalfa aphids, a higher female biased ratio occurred, which resulted in a more rapid population increase (Azam and Ali, 1970). Progeny of *Propylea 14-punctata* descending from parents consuming *Aphis helianthi* and *Hysteroneura setariae* exhibited a sex-ratio approaching the expected 50:50 ratio of females and males. Progeny from parents consuming aphid, *Rhopalosiphum maidis* (Fitch) had a sex-ratio of 2 female: 1 male (Rogers *et al.*, 1972).

However, the increase in the size of population and reduction in the mortality of the life stage of *C. septempunctata* from first to fourth generations proved that as

the quality of prey supplied to the ladybird beetle improved and prey proved more nutritious and the laboratory reared generations become more healthy. Thus when *C. septempunctata* is provided with the nutritions prey and suitably maintained abiotic conditions, the successful laboratory rearing of the *C. septempunctata* is possible and it will decrease the cost of mass multiplication of *C. septempunctata*.

Thus, the life-table studies confirm the following fact (1) net reproductive rate, intrinsic rate of natural increase and finite rate of increase were highest during fourth generation on the most nutritious prey. (2) Generation time and doubling time was highest on the least nutritions prey. (3) Mortality of different stages of *C. septempunctata* was lowest in fourth generation fed on more nutritious prey, *L. erysimi*, and highest in first generation when fed on the least nutritive prey, *R. maidis*. (4) The ladybird beetle faces the problem of an unstable and nonspecific food supply. (5) Eggs and larvae of *C. septempunctata* may face the problem of cannibalism or starvation. (6) Parasitization of the life stages of the ladybird is also a cause of mortality. (7) First instar is the key state. (8) Ladybird beetles do respond to the quality and the abundance of their prey. The finding thus suggests that the mass rearing of *C. septempunctata* may be done successfully in the laboratory by providing suitable prey and maintaining suitable abiotic conditions, which can later be utilized for the suppression of the pest populations in the fields.

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A solar light trap for monitoring forest insect populations

K. S. S. Nair[1], V. V. Sudheendrakumar*[1], T. V. Sajeev[1], George Mathew[1], K. Mohanadas[1], R. V. Varma[1] and T. Sivadas[2]

[1]*Division of Entomology, Kerala Forest Research Institute, Peechi 680653, Trichur, Kerala, India*
[2]*Agency for Non-conventional Energy and Rural Technology, Trivandrum 695014, Kerala, India*
Email: sudhi@kfri.org

ABSTRACT: Two indigenously designed light traps- one a fixed model and the other a portable model, powered by a Solar Photo-Voltage (SPV) System are described. The light source is a 20 W 'black-light' tube, which is switched on automatically at dusk, controlled through the SPV system. A timer facilitates automatic operation for pre-set periods. The insects can be trapped into a net-covered, walk-in chamber, from where live insects can be selectively collected on a collection box. Efficiency of the trap is reported on the basis of taxa of insects collected. These traps have several advantages over conventional light traps—facility to operate without electrically, operation for specific time periods, use of a black-light tube for greater effectiveness and facility for collection of live insects. ⓒ 2004 Association for Advancement of Entomology

KEYWORDS: Solar light trap, forest insects, pest population monitoring, *Hyblaea puera*

INTRODUCTION

Estimates of the number and kinds of insects present in a crop or a given locality are often required for various purposes. These include timing of the application of control measures, research into the factors determining the abundance and distribution of a species, or study of the insect fauna. Among the various methods used for this purpose, light traps are the most common, apparently because of their ease of operation. Light traps provide a relative estimate of insect numbers and species, essentially, of night-flying insects, over time or space. Although the exact mechanism by which the insects are attracted to light sources is not clear, a number of major groups including moths, beetles, bugs and grasshoppers are captured by light traps. Several standard types of

*Corresponding author

light traps have been developed, of which the Rothamsted trap, the Robinson trap and the Pennsylvanian trap are the most popular (Southwood, 1978).

A major limitation in the use of light traps is the necessity to have a supply of electricity at the site of operation. This is often difficult, particularly in rural and forest areas. To surmount this difficulty, attempts have been made to use car batteries as the source of electricity. However, the need to recharge the batteries at frequent intervals, which is either cumbersome or not practicable under some situations, is a serious handicap. In addition, the light intensity of battery-operated lamps will vary depending on the battery charge.

Incandescent (tungsten filament) bulbs of 100 to 200 watts are generally used in light traps. The Pennsylvanian trap uses a fluorescent tube. An increase in the intensity of light usually results in increased trap catches. Use of ultraviolet light also increases the trap catches, particularly of moths (Southwood, 1978). "Black-light" tubes emitting portions of the ultraviolet spectra, not harmful to the human eye, have recently been developed and are now commercially available. Since they are much more attractive than incandescent lamps, tubes of lower wattage can be used.

Considering all the above factors we developed a light trap using a black-light tube, powered by a battery. The battery is charged during the daytime, using sunlight, through a photo-voltaic system. Two models were developed, a fixed model and a portable model. Details of the trap system and trap efficiency are reported here.

I. Trap design

The light trap system consists of three sub-units: (1) the trap (Fig. 1) (2) the collection cage, and (3) the Solar photo-voltaic (SPV) system.

1. The fixed model (Fig. 2)

The trap: The basic trap unit is similar in design to the Pennsylvanian trap. It consists of a framework made of two flat iron rings, 30 cm in diameter, with cross arms in the middle, and connected together with 4 iron rods (Fig. 1). A tube holder is fixed at the centre of the cross arms of each ring, to hold a fluorescent tube. Aluminium channels fixed in the cross arms serve to hold 4 baffles, 60 cm tall and 12 cm wide, made of 4 mm thick transparent Perspex sheet. The baffles can be removed to replace the tube. A funnel, 30 cm diameter at top, made of 20 gauge smooth aluminium sheet, is fixed to the bottom ring of the framework. The tail of the funnel extends into a collection cage. Alternatively, the tail of the funnel passes through a hole cut in the centre of a stainless steel bottle cap to which a collection bottle can be screwed. The top ring supports a conical aluminium hood 45 cm in diameter at bottom, to protect the trap from rain. Insects are attracted by light emitted by a 20 W black-light fluorescent tube, 60 cm (24″) long. The tube, manufactured by Philips (Holland) is available in the local market. It works on single phase AC electric supply of 230 V, 50 Hz and emits light rays of low frequency (Wavelength 300 nm to 400 nm), not harmful to human beings. With a life of about 3000 lighting hours, it should work for over 8 months if lighted for 12 h daily.
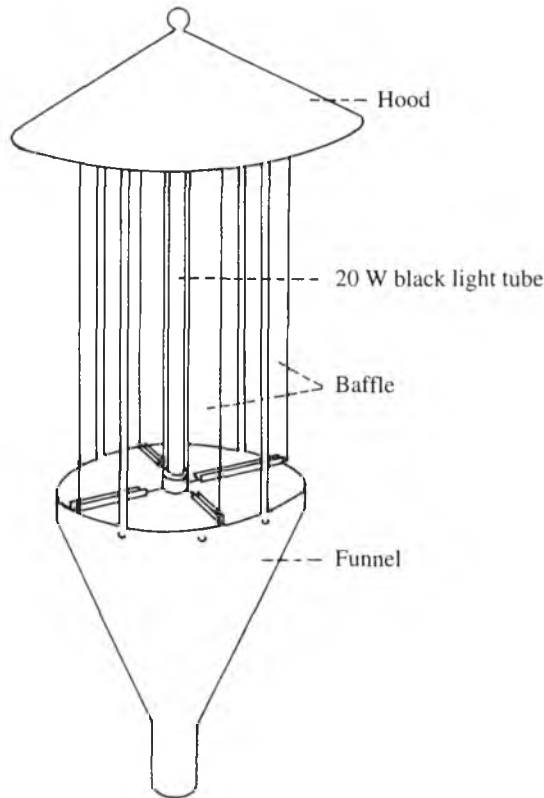
FIGURE 1. Design of the Light trap

The collection cage: The collection device is a walk-in-cage, 180 cm × 180 cm × 210 cm, made of angle iron frame and covered with nylon netting fixed with nuts and bolts. The cage is fixed on the floor with cement.

The solar photovoltaic system: The photovoltaic system consists of 4 numbers of 30 W (nominal) SPV panels and an electronic control unit. The SPV panels were obtained from the Ministry of Non-conventional Energy Sources, Government of India. The battery is of tubular low-maintenance type so that it can take deep cycles of charging and discharging without getting damaged. The electronic control unit has two sections, namely charge controller and inverter. The charge controller ensures that the battery is neither overcharged nor over-discharged, with cut-off voltages at 13.8 and 10.5 V respectively. The inverter operates at 20 kHz with a secondary voltage of 200 V on load. The Solar panels are mounted on a steel pole, 2.6 m height and 7.5 cm

Light trap

Walk-in cage

Battery Box
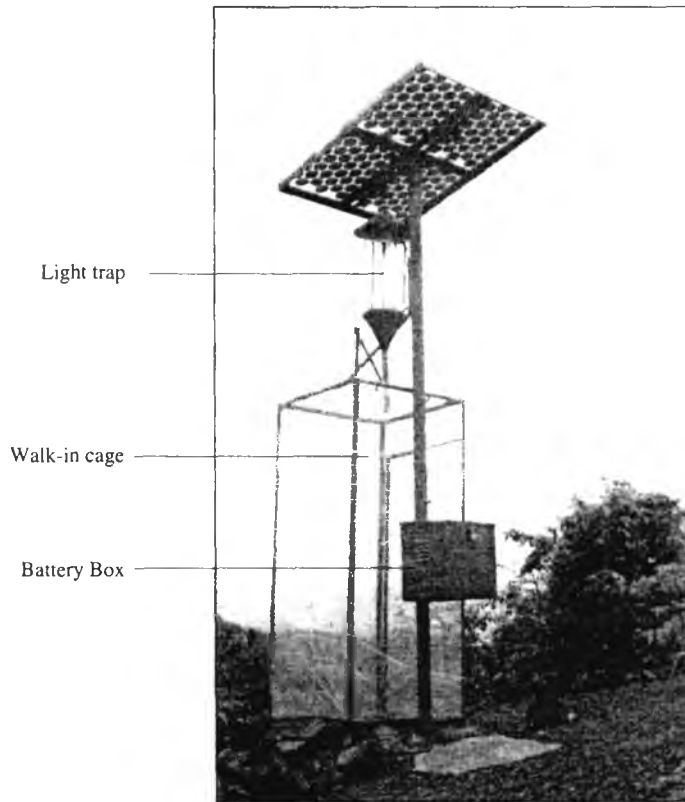
FIGURE 2. Fixed Model Light Trap System installed at Kariem-Murieum in Nilambur, Kerala

diameter. The battery and electronic control unit are housed in a box mounted on the pole to protect them from rain and dust.

Operation of the trap: Using a timer, the trap can be operated for pre-set periods. The light can also be switched on automatically at dusk through the SPV system by sensing the ambient light intensity.

2. Portable model (Fig. 3)

Since the solar panels are mounted on a pole fixed on the ground, the fixed model trap is not easily transportable to other locations. Hence a portable model was also designed. In this model, the pole is fixed on a base and all the accessories are mounted on the pole so that the whole unit can be shifted conveniently to any location. This model uses only a single solar panel and a 12 V car battery. The pole, made of steel
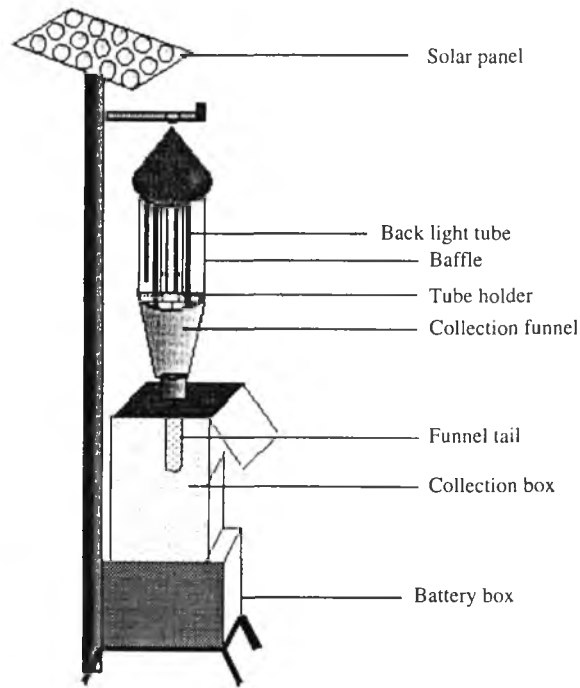
FIGURE 3. Portable model light trap system

pipe, is 1.5 m in height and 6 cm in diameter. The trap is hung on the adjustable clamp provided on the pole. The clamp can be tightened at required height to keep the funnel of the trap firmly at the mouth of the collecting cage. The trap can be continuously operated for about 4 h daily.

Trap efficiency

The trap was developed in connection with a study on the population dynamics and control of the teak defoliator, *Hyblaea puera* (Lepidoptera, Hyblaeidae), to monitor its seasonal incidence in teak plantations at Nilambur. As there is no supply of electricity within the nearly 1000 ha teak plantation under study, it was not possible to operate a conventional light trap. The trap system described here was set up within this plantation area at Kariem-Muriem, on the top of a hillock at Ambalakunnu. It was operated for 6 h every night, starting at dusk. The trap catch of *H. puera* for the initial two months of its operation during June–July 1993 is shown in Fig. 4. It reflected the larval infestation pattern observed in the plantation.

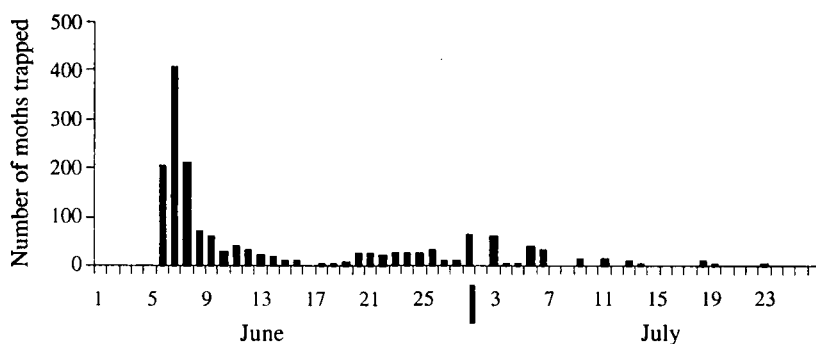FIGURE 4. Trap catch of *Hyblaea puera* moths in June–July 1993 at Kariem-Muriem, Nilambur

TABLE 1. Insects collected in the light trap during 9 days of sampling

Insect order	Family	No. of species recorded
Orthoptera	Acrididae, Gryllotalpidae, Gryllidae	4
Trichoptera	unidentified	2
Dermaptera	unidentified	1
Dictyoptera	Mantidae	1
Coleoptera	Carabidae, Cicindelidae, Dytiscidae, Tenebrionidae, Dynastidae, Chrysomelidae, Coccinellidae, Cerambycidae, Scarabaeidae, Rutelidae, Staphylinidae, Dyticidae, Unidentified family	13
Hemiptera	Belostomatidae, Pyrrhocoridae, Lygaeidae, Pentatomidae, Coreidae, Cicadellidae, Dictyophoridae	12
Hymenoptera	Formicidae, Ichneumonidae	4
Diptera	Muscoidea, Culicidea	2
Lepidoptera	Noctuidae, Hypsidae, Sphingidae, Arctiidae, Pyraloidea, Tineidae, Geometridae, Thyrididae	28

To assess the trap's efficiency for other groups of insects, all the insects trapped for a 9-day period in the month of July were collected and grouped to the species level. The data are presented in Table 1. It may be seen that altogether 67 species of insects were collected from within the teak plantation area, which also contained some marshy sites and bamboo clumps. The collection represented species belonging to 9 insect orders. The largest number of species were trapped from the Order Lepidoptera, followed by Coleoptera and Hemiptera. The results of this 9-day collection during the first half of the night show that the trap is efficient for monitoring a large variety of insect species.

DISCUSSION

Preliminary results show that the light trap system described here is efficient for monitoring the population trends of chosen species of insects as well as for collecting several groups of insects. Initial attempts to collect the insects in a bottle of 1 litre capacity fixed to the bottom of the funnel were not satisfactory as the bottle got filled with insects within about an hour, thus preventing further entry of insects. It was therefore decided to switch over to the walk-in cage system to facilitate a more representative collection. Walk-in type of cage is also preferable on many other counts. By changing the mesh size of the screened cage, unwanted insects of smaller size can be allowed to escape. After the required insects are collected, other insects can be flushed out through the open door. Thus unnecessary destruction of the insect fauna, including beneficial insects can be prevented. Use of the cage also permits collection of live insects.

The major advantage of this trap system is that it can be deployed in rural and remote areas where supply of electricity is not available. Many forest sites fall under this category. However, the high cost of the solar panel is a disadvantage in other areas.

In addition to the use of the SPV system, the light trap described here incorporates other desirable features such as the simple trap design, use of locally available black-light tube and the walk-in collection cage, which are not commonly used for insect light traps in India. The latter features can also be used with advantage for light traps operating on regular AC supply or batteries.

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On a collection of *Melanophthalma* Motschulsky from Manipur, India with description of a new species (Coleoptera: Lathridiidae)

T. K. Pal

Zoological Survey of India, M-Block, New Alipore, Kolkata 700053, India

ABSTRACT: *Melanophthalma* Motschulsky is recorded from Manipur with two species: *M. prominens* Johnson and *M. manipurensis* sp. nov. The species are characterized and a key to the Indian species of *Melanophthalma* is given.
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KEYWORDS: Coleoptera, Lathridiidae, *Melanophthalma* Motschulsky, New species, Manipur

INTRODUCTION

Motschulsky (1861) described four species of Lathridiidae, *viz.*, *fuscotestacea*, *convexipennis*, *umbripennis* and *inflata* from Sri Lanka (erstwhile Ceylon) under the genus *Corticaria* Marsham. Motschulsky (1866) erected the genus *Melanophthalma* on the basis of *angulicollis* Motschulsky plus above four species. Hetschko (1926) synonymised *inflata* with *Corticarina gibbosa* (Herbst). Johnson (1972) allocated *convexipennis* and *umbripennis* to the genus *Corticarina* Reitter, resembling his species *gangolae* described from Uttaranchal (Johnson, 1970). Johnson (1972) described four species of Melanophthalma from India and Nepal. Hitherto, four species *viz.*, *evansi* Johnson, *franzi* Johnson *angulicollis* Motschulsky and *prominens* Johnson are recorded from India. While studying a collection of lathridiids from Manipur some five examples of *Melanophthalma* were examined and these belong to *M. prominens* Johnson and an undescribed species. These are described in the paper, which forms the first report of Lathridiidae from the Manipur State.

Systematic account

Genus *Melanophthalma* Motschulsky 1866, *Melanophthalma* Motschulsky, *Bull. Soc. Imp. Nat. Moscou* **39** (3): 269 (Type-species: Not designated).

Diagnosis: Elongated, moderately depressed, punctate-pubescent. Head broader than long, eyes large, transverse impressed line on vertex behind eyes, temple weakly developed or absent; antenna 11-segmented, antennal insertions dorso-lateral, scape large, pedicel shorter and narrower than scape, segments 3–8 more or less elongate, club 3-segmented. Prothorax transverse, narrowed behind anterior third or somewhat parallel, margin serrated, transverse prebasal fovea on pronotum, front coxal cavities closed, coxae narrowly separated. Scutellum transverse with transverse carina. Mesocoxae more widely separated than in front coxae. Elytra more wider than prothorax, elongate-ovoid, punctures on linear striae, setae posteriorly directed. Legs narrow, slender, trochanters simple, femora swollen towards middle, tibiae slender, tarsi simple and 3-segmented, segment 1 elongate and lobed below, segment 2 elongate and simple, segment 3 longer than remaining together, claws simple. Abdomen short and broad, intercoxal process of first abdominal ventrite broad and truncate, with femoral lines, ventrites 2–5 shorter.

Distribution: India, Sri Lanka, Nepal, Japan, Korea, Saudi Arabia, Sierra Leone, Ghana, West Indies Is., Argentina.

Melanophthalma prominens Johnson, 1972. *Melanophthalma prominens* Johnson, *Entomologist*, **105**: 108 (Type loc.-Nilgiri Hills, Tamil Nadu).

Diagnosis: Pronotum strongly transverse, broadest across middle, with a well developed transverse depression behind middle; sides of prothorax irregularly and coarsely serrate, in the middle with a well marked angular projection, the sides narrowed basally behind this, posterior angles with strong teeth. In male anterior tibia with a tooth on the undersurface a little in front of the middle; ventrite 5 with the apical margin shallowly emarginate in middle and this emargination is delimited by a minute tubercle on either side; tip of aedeagus somewhat pointed (Fig. 3). Length 1.7 mm.

Material: 1 ex: male. India: Manipur, Bishenpur Distt., Itahi, nr. Keibul, 930 m. 27.1.1998, T.K. Pal, *ex*. beating bush.

Distribution: India: Tamil Nadu, Uttaranchal, Bihar, Manipur (New recorded); Nepal.

Melanophthalma manipurensis **sp. nov.**

General appearance (Fig. 1) elongated, moderately convex, somewhat shiny, colour reddish-brown, antennae and legs slightly paler. Head broader than long, temple very thin, vertex finely and sparsely punctate; antenna slender and slightly shorter than head and prothorax together, scape moderately large and elongate, pedicel shorter and narrower, segments 3–7 narrower and more or less elongate, segment 8 slightly broader than preceding segment, club moderately broad, segment 9 about as broad as long or feebly elongate, segment 10 little transverse and apical segment elongate, segments 10 and 11 little wider than segment 9. Prothorax rather transverse (1.0:1.3), broader in posterior half than across front margin, sides feebly arched, somewhat parallel behind anterior third, margin feebly dentate, lateral teeth about 8–9 in number and setose, transverse prebasal fovea on pronotum moderately prominent, pronotal
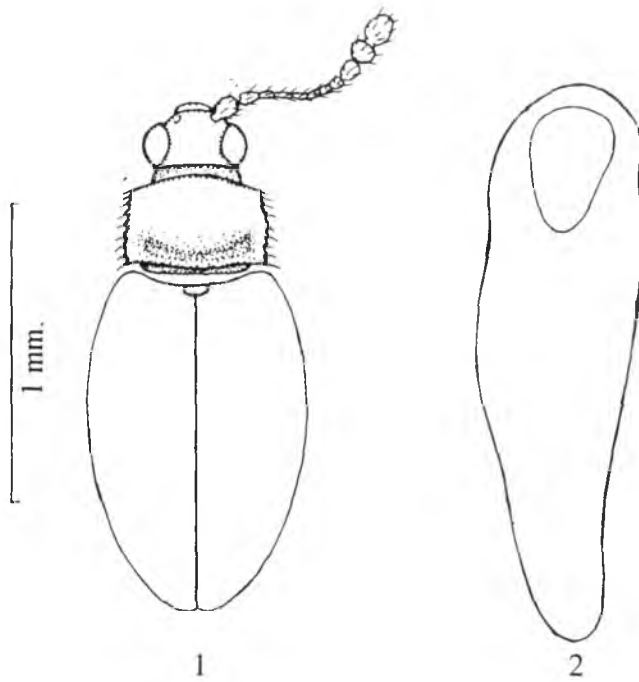
FIGURES 1–2. *Melanophthalma manipurensis* sp. nov.: 1, Dorsal view; 2, Aedeagus, Dorsal view.

FIGURE 3. Aedeagus of *Melanophthalma prominens* Johnson, Dorsal view.

surface moderately coarsely and densely punctate, discal punctures separated by the diameter of punctures or lesser than those, hind angles weakly toothed. Elytra long oval, 1.5x as long as broad, about 3.5x as long as prothorax, broadest more or less around middle, sides gently arched, striae with moderately coarse punctures separated on row by 3–5x of their diameter, hairs arising from interstices long and outstanding, hairs arising out of the punctures are shorter. Male: anterior tibia not toothed, ventrite 5 with apical margin entire and devoid of any characteristic feature; aedeagus characteristic as in Fig. 2, apex slightly narrowed but not pointed.

Measurements of the holotype:

Total length 1.64 mm, width of head across eyes 0.40 mm, length of antenna 0.57 mm, length and width of prothorax 0.32 mm, and 0.50 mm, length and width of elytra 1.20 mm and 0.80 mm.

Hototype:

♂, India: Manipur, Imphal District, Imphal, Mantripukhri, 930 m., 4.ii.1998, T.K. Pal, *ex*: beating bush; *Paratypes* 2 *ex.*, data same as above; *Paratypes* 3 *ex.*, Imphal, Tulihal, 930 m., 3.iii.1998, T.K. Pal, ex. beating bush (Zoological Survey of India, Kolkata).

Etymology:

The species-name refers to its occurrence in the State of Manipur of the Indian Union.

Remarks:

This species comes close to *Melanophthalma franzi* Johnson but can be differentiated by its prothorax not angular but somewhat parallel behind anterior third; transverse prebasal impression on pronotum less prominent; and structure of aedeagus different.

KEY TO THE SPECIES OF *MELANOPHTHALMA* MOTSCHULSKY FROM INDIA

1. Temples moderately well developed, about as long as apical width of first antennal segment; elytra short and broad (about 1.4x as long as broad) . . . *evansi* Johnson

  - Temples indistinct or weakly developed; elytra longer (at least 1.5x as long as broad) 2

2. Sides of prothorax not angulate at middle, somewhat parallel-sided behind anterior third . . . . *manipurensis* sp. nov.

  - Sides of prothorax more or less angulate at middle 3

3. Sides of prothorax slightly angulate at middle but not produced, so that the middle is only a little broader than base . . . . *franzi* Johnson

  - Sides of prothorax angularly produced at middle, so that middle is much broader than base 4

4. Temples weakly developed; hind margin of abdominal sternite 5 truncate but not emarginate . . . . *angulicollis* Motschulsky

- Temples indistinct or absent; hind margin of abdominal sternite shallowly emarginate, emargination is delimited on either side by tubercle . . . . . *prominens* Johnson.

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Effect of parasitoid-host ratio on some biological attributes of *Tetrastichus howardi* (Olliff) (Hymenoptera: Eulophidae)

Arun Baitha*[1], S. K. Jalali[2], R. J. Rabindra[2], T. Venkatesan[2], N. S. Rao[2] and Y. Lalitha[2]

[1]*Division of Crop Protection, Indian Institute of Sugarcane Research, Rae Bareli Road, Dilkusha P. O., Lucknow 226002, Uttar Pradesh, India*
Email: arunbaitha@rediffmail.com
[2]*Project Directorate of Biological Control, P.B. No 2491, H.A. Farm Post, Hebbal, Bellary Road, Bangalore 560024, Karnataka, India*

ABSTRACT: Biological attributes of *Tetrastichus howardi* (Olliff) was studied on *Chilo partellus* (Swinhoe) pupae at different parasitoid-host densities at $25 \pm 2\,°C$ and $65 \pm 5\%$ RH. Highest parasitism, maximum adult emergence and increased proportion of female progenies were recorded when the parasitoid-host ratio was kept at 1:1, which was significantly superior to other ratios. The extent of parasitism decreased when the parasitoid-host/host-parasitoid ratio increased. Therefore, 1:1 parasitoid-host ratio is desirable for the mass multiplication of *To. howardi* on *C. partellus*.
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KEYWORDS: Pupal parasitoid, *Tetrastichus howardi*, super parasitism, *Chilo partellus*, host-parasitoid ratio

INTRODUCTION

Tetrastichus howardi (Olliff) is a gregarious and polyphagous pupal endoparasitoid with wide host range (Cherian and Subramaniam, 1940; Puttarudriah and Sastry, 1958; Moore and Kfir, 1995). If parasitoids are reared in high densities during mass production, it leads to reduction in searching efficiency (Varley *et al.*, 1973), reduction in fecundity (Evans, 1976; Kfir *et al.*, 1976) and a pronounced shift towards a preponderance of males in the progeny (Viktorov, 1968; Kfir and Rosen, 1981). Superparasitism is a common phenomenon when hosts are exposed to different female densities of *T. howardi* under laboratory conditions. Literature on superparasitism by *T. howardi* being very scanty, the present study was undertaken to determine

*Corresponding author

the host-parasitoid ratio of *T. howardi* for laboratory multiplication and to avoid superparasitism.

MATERIALS AND METHODS

T. howardi was maintained on the pupae of *Chilo partellus* (Swinhoe), reared on artificial diet as per methods described by Ballal *et al.* (1995).

Host pupal ratio

Newly emerged mated females of *T. howardi* were kept singly in eight test tubes (15 × 2.5 cm). Each individual female was provided with varying number of pupae of *C. partellus* i.e. one, two, three, four, five, six, seven, and eight pupae per female. The parasitoids were provided with fine streaks of honey—water solutions (1:1 v/v) as food. The individual females were confined for 24 h to parasitise the pupae. After confinement, the parasitoids were removed.

Parasitoid ratio

Fresh pupae of *C. partellus* were kept singly in five separate test tubes (15 × 2.5 cm). Each host pupa was provided with one, two, three, four and five female parasitoids. After 24 h of parasitization, the adults were removed.

The entire study was conducted at $25 \pm 2\,^{\circ}\text{C}$ and $65 \pm 5\%$ RH with five replications. The observations on the percentage parasitisation, adult emergence, developmental period (days) and female progeny were recorded. The data were subjected to Analysis of Variance. The percentage data were transformed (arcsine) before analysis.

RESULTS AND DISCUSSION

Host pupal-parasitoid ratio

Percentage parasitism varied from 8.0 to 100.0% in different host-parasitoid ratios (Table 1). Maximum percentage parasitism (100.0%) was recorded in 1:1 host-parasitoid density, which was significantly different from other host–parasitoid ratios tested. A large proportion of hosts escape parasitism while increasing the host ratios (Morrison and Strong, 1980). The number of adults emerged from different host ratios varied from 33.0 to 79.5 per pupa and maximum was in 1:1 host-parasitoid ratio. Developmental period of the parasitoid varied from 16 to 20 days and it was at par in host-parasitoid ratios of 1:1, 2:1 and 3:1. Maximum female progeny was obtained in 1:1 ratio followed by 2:1, which were significantly different from the rest of the host ratios. Female progeny, the number of which is of great importance to the survival of a species, was severely influenced by the host density. Female progeny sharply fell from 96.3 at 1:1 to zero at 8:1 host-parasitoid ratio. The increased daughter mortality on super parasitised hosts is a selective factor to counteract increased laying of male eggs on these hosts (Alphen and Nell, 1982; Lawrence, 1981). The response of *T. howardi* to the widening of host ratios, resulting in a decrease in the proportion of female offspring

TABLE 1. Effect of different host ratios on the parasitisation of *Tetrastichus howardi*

Host-Parasitoid ratio	Parasitization (%)	No. of adults emerged/pupa	Developmental period (in days)	Female progeny (%)
1:1	100.00^a	79.5^a	17.00^a	96.28^a
2:1	40.00^b	70.5^a	15.67^a	90.10^a
3:1	20.00^c	65.0^b	17.00^a	40.00^b
4:1	20.00^c	49.5^b	18.00^b	33.80^b
5:1	15.0^c	40.8^b	18.33^b	32.32^b
6:1	13.3^d	38.7^c	18.33^b	30.00^b
7:1	13.3^d	34.0^c	20.00^c	15.58^c
8:1	8.0^d	33.0^c	20.00^c	0.00^c
SEM	2.032	3.68	0.4859	8.32

In a column means followed by similar letters are not statistically different ($P = 0.05$) by DMRT.

TABLE 2. Influence of different *Tetrastichus howardi* female ratios on parasitisation of host pupae

Parasitoid host ratio	Parasitization (%)	No. of adults emerged/pupa	Developmental period (in days)	Female progeny (%)
1:1	100.00^a	79.5^a	17.00^a	96.28^a
2:1	80.00^b	41.4^a	16.00^a	92.70^a
3:1	80.00^c	34.5^b	16.00^a	92.20^b
4:1	60.00^c	24.8^b	16.00^b	78.58^b
5:1	40.00^c	23.8^b	15.00^b	56.22^b
SEM	3. 578	8.20	0.24	8.19

In a column means followed by similar letters are not statistically different ($P = 0.05$) by DMRT.

can be considered as mortality of potential females. The present findings revealed that 1:1 host-parasitoid ratio is suitable for mass multiplication of *T. howardi*. There were no such studies carried out earlier elsewhere so no comparisons could be made.

Parasitoid ratio

Highest parasitism (100%) was recorded when single *C. partellus* pupa was exposed to individual female of *T. howardi* (1:1 parasitoid-host density ratio) which was significantly different from other ratios (Table 2). The percent parasitism declined when the parasitoid-host ratio increased from 1:1 to 5:1. Lowest parasitism was observed in 5:1 ratio. Maximum number of adults (79.5) emerged in 1:1 ratio, which

was significantly higher than those in other ratios. The competition between the developing parasitoids for the available amount of food in the host pupa appears to be the factor that inhibits the normal development of the parasitoid. Developmental period of *T. howardi* in 1:1, 2:1, 3:1 and 4:1 ratios ranged from 16–17 days and it was at par with each other. The number of female progeny emerged was maximum (96.3) in 1:1 ratio followed by 2:1, 3:1 and 4:1 which were statistically on par with each other and significantly different from 5:1. In laboratory breeding, exposure to a large number of parasitoids will lead to competition among them resulting in super parasitism. Hence, 1:1 parasitoid-host ratio can be adopted for the mass multiplication of *T. howardi* for obtaining increased parasitism, highest number of adults and maximum female progenies.

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Observations on the ootheca of some Indian tortoise beetles (Coleoptera: Chrysomelidae: Cassidinae)

K. K. Verma*[1] and T. Kalaichelvan[2]

[1]*HIG-1/327, Housing Board Colony, Borsi, Durg, Chhattisgarh 491001, India
Email: kkvermain@sancharnet.in*
[2]*Maitri Baag Zoo, Bhilai Steel Plant, Bhilai, Chhattisgarh 490006, India
Email: tkchelvan@rediffmail.com*

ABSTRACT: Some observations on oothecae of Indian Cassidines, not recorded so far, are described. The species covered in this study include *Oocassida pudibunda, Cassida exilis, C. residua, Rhytidocassis indicola, Aspidomorpha furcata* and *A. sanctaecrucis.* An attempt has been made to make out directions of ootheca elaboration among cassidines to improve its protective value. It is inferred that these changes have taken place independently a number of times among the cassidines.
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KEYWORDS: *Ootheca, Oocassida pudibunda, Cassida species, Rhytidocassis indicola, Aspidomorpha* species

INTRODUCTION

Eggs of leaf beetles (Chrysomelidae) are often provided with a special protective contrivance. This situation is nearly universal among tortoise beetles (Cassidinae) (Olmstead, 1994, 1996). Earliest descriptions of such protective devices for eggs of cassidines are from Muir and Sharp (1904) and Kershaw and Muir (1907). The former authors dealt with African species, and the latter with Chinese forms.

Maulik (1919) described the egg cover or ootheca of the Indian cassidine, *Aspidomorpha miliaris* F., and gave a figure of an ootheca of another Oriental species, *Aspidomorpha sanctaecrucis* F. Takizawa (1980) gave an account of immature stages of 14 Indian species of cassidines. His description covers mainly larval and pupal stages, but he has also briefly mentioned egg protection in most cases. Egg protection in some Indian cassidines is included also in papers by Rawat and Modi (1972), Visalakshi *et al.* (1980), George and Venkataraman (1987), Kalaichelvan and Verma (2000), Rane *et al.* (2001) and Borowiec *et al.* (2001).

*Corresponding author

We have made some additional observations on egg protection in cassidines which are reported in this paper.

MATERIALS AND METHODS

The observations have been made mostly in the field at and around the twin city of Durg-Bhilai (Chhattisgarh, India). Some of the observations have been repeated in the laboratory with the insect and the host plant leaves in glass culture jars.

Observations

Oocassida pudibunda Boh.

Ootheca of this species has been described by Rawat and Modi (1972). They find the ootheca as a blackish structure containing 1 to 4 eggs, and have not mentioned addition of maternal excreta to the ootheca. Kalaichelvan and Verma (2000), describing the ootheca of *O. cruenta* F., have pointed out addition of fecal matter to the glandular secretion covering the egg, and have described the excretory deposit as hard, perhaps because colleterial gland secretion is mixed up with maternal excretion.

It was observed that *O. pudibunda* female, after laying an egg, makes a transparent cap over it, and then supplements the transparent glandular secretion with a fecal discharge. The fecal deposit does not present any definite outline, but is diffuse and spreads all over the glandular cap [Fig. 1(a)]. When the ootheca has been freshly deposited the fecal deposit can be removed with a needle, revealing a brownish glandular secretion cover. But after sometime the fecal deposit is hard and cannot be removed or scraped away from the oothecal cap. Now it does not disperse in water or rectified spirit. In contrast, other cassidines, which cover the ootheca with excrement, e.g. *Glyphocassis trilineata* Hope, *Chiridopsis promiscua* Both., *Rhytidocassis indicola* Duv. and *Cassida residua* Ws., the excrement can be easily removed with a needle or on immersion in water or alcohol. Perhaps, in *O. pudibunda* the excretory discharge over the forming ootheca is mixed up with colleterial secretion, and thus becomes a part of the hard egg cover. Usually an ootheca of this species encloses a single egg [Fig. 1(b)] and sometimes two. The oothecae are deposited mostly on upper surface of tender leaves.

Cassida exilis Boh.

Ootheca of this species is transparent, with parchment like cover over the egg (Fig. 2), overlaid by maternal fecal deposit. It encloses 1 or 2 eggs. The fecal deposit is easily removable. The oothecae are formed mostly on undersurface of leaves.

C. residua Ws.

Ootheca of *C. residua* is quite similar to that of *C. exilis*. It encloses one or rarely two eggs, and is covered with maternal excreta. In this species, the oothecae are deposited mostly on upper surface of host plant leaves, and along the mid-vein; never along lateral veins (Fig. 3).
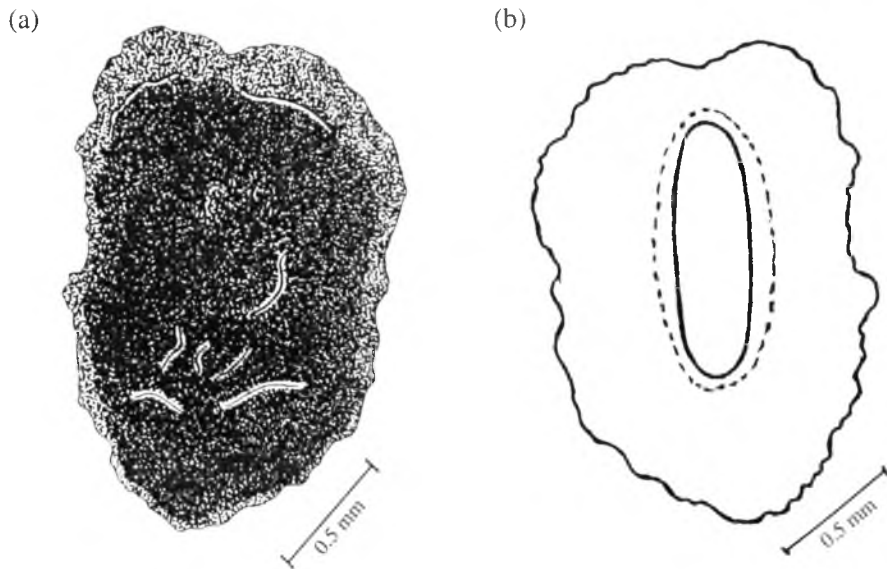
(a) (b)

FIGURE 1. An ootheca of *Oocassida pudibunda.* (a) view from upper side (b) underside, showing the egg.
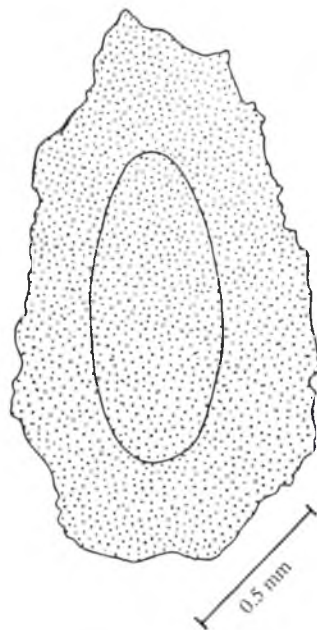

FIGURE 2. An ootheca of *Cassida exilis*, from upper side. Maternal excreta has been removed, and an egg is seen through transparency of glandular cover.
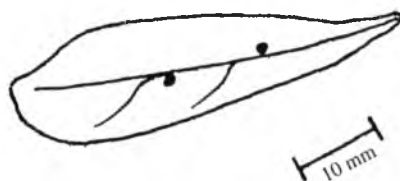
FIGURE 3. Two oothecae of *Cassida residua* on a leaf of the host plant, *Alternanthera philoxeroides*.
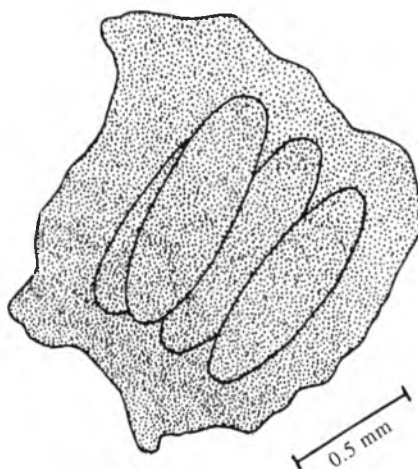
FIGURE 4. An ootheca of *Rhytidocassis indicola* from the upper side, with the fecal deposit removed.

Rhytidocassis indicola (= Cassida indicola) Duv.

Ootheca of this species is a nearly oval cap, brownish, and made with a comparatively large quantity of glandular secretion. It does not readily flex under pressure, encloses one to 4 eggs (Fig. 4), and only rarely covered with maternal excreta. The oothecae are generally deposited on lower surface, in the basal part of the leaf.

Aspidomorpha furcata Thunb.

Ootheca of *A. furcata* has been described by Visalakshi *et al*. (1980). It is small boat-like tray, with a flap like cover over it. The boat contains one egg. The authors point out, '1 to 3 trays may be laid together arranged one above the other'. Gressitt and Kimoto (1963) have included in their monograph a figure of *A. furcata* ootheca, enclosing five eggs.

As per our observations, an ootheca of *A. furcata* encloses 1 to 2 eggs. It is always deposited on the under surface of leaves. When winter is approaching, the oothecae

FIGURE 5. An ootheca of *Aspidomorpha sanctaecrucis*, cut across to reveal egg chambers in the nearly horizontal and overlapping lamellae.

are smaller, and proportion of oothecae with only one egg increases. If there are two eggs in an ootheca, they are in separate chambers, separated by a membrane.

A. sanctaecrucis Fabr.

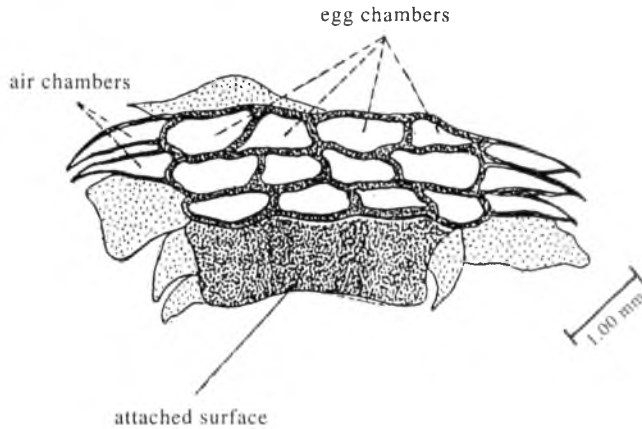As in *A. miliaris* F. (Maulik, 1919; Kalaichelvan and Verma, 2002) the ootheca is complex, and is made up of a number of lamellae, presenting an overlapping arrangement. Each lamella encloses four egg chambers, each with an egg, and two air-holding chambers, one on either side (Fig. 5). A difference from ootheca of *A. miliaris* is that in *A. sanctaecrucis* the egg bearing lamellae are placed almost horizontally, as in the Australian *A. maculatissima* Boh. (Hawkeswood, 1982), and not obliquely vertically as in *A. miliaris*. The oothecae of *A. sanctaecrucis* are formed mostly on the lower surface of leaf.

DISCUSSION

On comparing egg protection in Indian cassidines, it appears that changes have taken place in three main directions, as illustrated in (Fig. 6). Simplest condition of the ootheca is in *Aspidomorpha furcata* and *A. spaethi* Maulik (Takizawa, 1980). In these species, the egg case is a simple brownish transparent capsule, enclosing a single egg (1 to 4 eggs in *A. furcata*).

One direction of ootheca elaboration, to increase its protection value, is formation of ridges and valleys to make the colleterial secretion cover over the egg more rigid and less flexible. For example: (i) *Cassida circumdata* Hbst.—the ootheca of this species is elongated oval, encloses a single egg, and shows two longitudinal thickenings and a number of transverse creases, giving the structure "the appearance of a double keeled boat turned over" (Kershaw and Muir, 1907). The ootheca has been described by
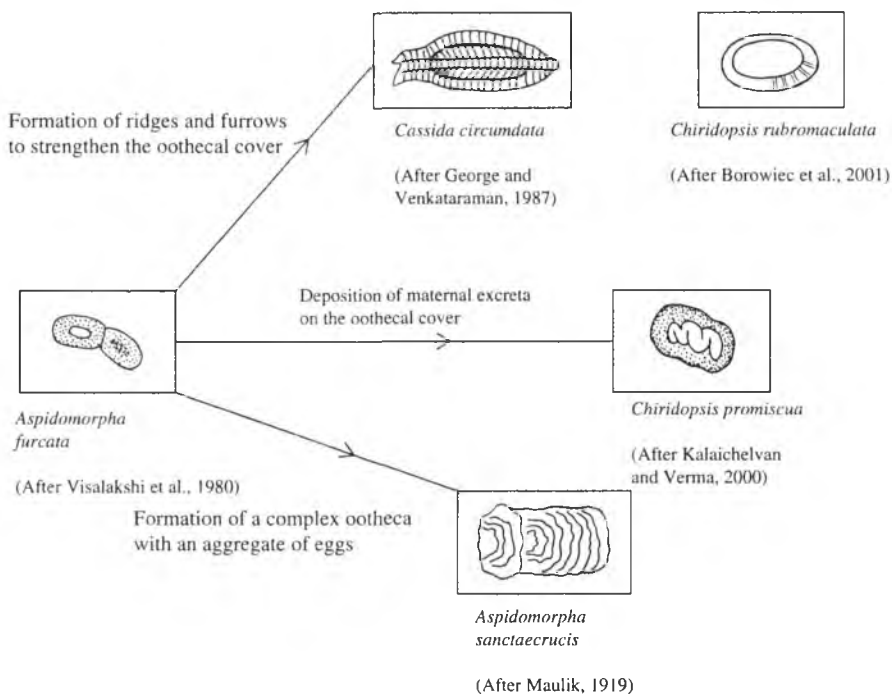
FIGURE 6. A diagram to illustrate the three main directions of ootheca elaboration in cassidines. (The oothecae, have not been drawn to the same scale.)

Kershaw and Muir (1907), Yeung (1934) and George and Venkataraman (1987). (ii) *Conchyloctenia nigrovittata* Boh. An ootheca of this species is also shaped like an inverted boat, but it presents a single longitudinal keel with transverse creases (Rane *et al.*, 2001). (iii) *Chiridopsis rubromaculata* Borowiec *et al.*An oval ootheca of this species presents radially placed vertical ridges and furrows in its periphery (Borowiec *et al.*, 2001).

Another direction of ootheca elaboration is deposition of maternal excreta over a simple cap of hardened colleterial secretion, enclosing a single or a few eggs, eg. *Chiridopsis promiscua* Boh., *Glyphocassis trilineata* Hope and *Oocassida cruenta* Fabr. (Kalaichelvan and Verma, 2000). The fecal deposit not only conceals the egg/eggs, but may also have chemical defense value. It has been shown by Vencl and Morton (1999) that the fecal shield of chrysomelid larvae may contain chemically altered metabolites of the host plant. Such chemicals are of toxic nature, and have protective value. The same may be true for the fecal cover of cassidine eggs. Experimental evidence in support of this suggestion, however is scanty. Olmstead (1994) has mentioned one such experiment. Egg masses of the hispine *Microrhopala* are covered with maternal fecal discharge. If the fecal cover is removed predators readily attack the eggs. Eggs with fecal cover are not destroyed by predators.

A third line of elaboration is piling up of simple oothecae or gland secreted egg covers to form a complex ootheca, which encloses an aggregate of eggs. Such complex oothecae are known, for example in *Aspidomorpha miliaris* and *A. sanctaecrucis*. When a number of eggs are in a cluster, there is possibility of some eggs/immature stages surviving a parasitoid or predator attack for the following reasons: (i) the reproductive capacity of the parasitoid may be limited; hence some eggs in the aggregate may remain unparasitised, (ii) some eggs in the cluster may act as a shield for the eggs lying below them or concealed by them (iii) Larvae, hatching from the eggs may readily take to a group protection strategy like cycloalexy (Olmstead, 1996; Jolivet, 1997). Gregoire (1988) has observed that the naked eggs of the hispine *Cephaloleia consanguinea* Baly are laid in a cluster and are not destroyed 100% in a parasitoid attack.

The directions of changes, shown in Fig. 6, should not be confused for phyletic lines. Changes in these directions seem to have occurred a number of times independently among cassidines. Formation of simple capsule like ootheca in *Aspidomorpha spaethi* and that of a complex ootheca, enclosing numerous eggs in *Aspidomorpha miliaris* or *A. sanctaecrucis* have taken place within the limits of a single genus. In *A. furcata* there is a tendency of simple oothecae piling up to form a little cluster (Visalakshi *et al.*, 1980). As inferred by Windsor and Choe (1994), parental care of immature stages which is confined to South American cassidines, has evolved independently twice.

Fig. 6 shows lines of elaboration of cassidine oothecae in a rather simplified version for comprehension; actual situation is more complex. For example, in *Rhytidocassis indicola*, as pointed out in the previous section, the oothecal cap is not readily flexed, due to ample quantity of the glandular product used in its construction. It does not have ridges or creases, and is only rarely covered by mother's excreta. The oothcal glandular secretion cover of *Glyphocassis trilineata* is not only overlaid by maternal excreta, it also presents low radial creases in the periphery.

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Taxonomic studies on the family Tortricidae (Tortricoidea: Lepidoptera) from North-West India: I. Tribe Archipini (Tortricinae)

H. S. Rose and Harjit Singh Pooni

Department of Zoology, Punjabi University, Patiala 147 002, Punjab, India
Email: profithsrose@yahoo.com
Email: harjitpooni@yahoo.co.in

ABSTRACT: Twenty species belonging to nine genera *viz.*, *Mocholopyga* Diakonoff, *Archips* Hübner, *Clepsis* Guenée, *Dicelletis* Meyrick, *Ulodemis* Meyrick, *Neocalyptis* Diakonoff, *Meridemis* Diakonoff, *Homona* Walker and *Scotiophyes* Diakonoff referable to tribe Archipini (Tortricinae) of the family Tortricidae have been collected from the North–West India and dealt with taxonomically. Key to the presently examined genera has been prepared on the basis of characters such as the labial palpi, antennae, abdominal pits, costal fold, wing venation and male and female genitalic characteristics. Further, keys to the species of the genera such as *Archips* Hübner, *Clepsis* Guenée, *Neocalyptis* Diakonoff and *Meridemis* Diakonoff represented by more than one species have also been furnished. Eight species i.e. *Archips mertias*, *A. pseudotermias*, *A. kangraensis*, *A. carteri*, *Clepsis neomelissa*, *Neocalyptis conicus*, *Meridemis punjabensis* and *M. obraztsovi* have been reported as new to science. The species *viz.*, *Ulodemis trigrapha* Meyrick and *Meridemis bathymorpha* Diakonoff have been reported for the first time from India. Similarly, the species *Mocholpyga humana* (Meyrick), *Clepsis tricensa* (Meyrick), *C. melissa* (Meyrick), *Dicelletis nigritula* (Meyrick), *Neocalyptis affinisana* (Walker) and *Meridemis invalidana* (Walker) have been collected for the first time from this area. Besides giving an illustrated account of the new species, the genitalic account of already known species i.e. *Mocholpyga humana* (Meyrick), *Archips machlopis* (Meyrick), *A. termias* (Meyrick), *Clepsis tricensa* (Meyrick), *C. melissa* (Meyrick), *Dicelletis nigritula* (Meyrick), *Ulodemis trigrapha* Meyrick, *Neocalyptis affinisana* (Walker), *Meridemis invalidana* (Walker), *M. bathymorpha* Diakonoff, *Homona coffearia* (Neitner) and *Scotiophyes faeculosa* (Meyrick) have been added to improve their diagnosis. © 2004 Association for Advancement of Entomology

KEYWORDS: Lepidoptera, Archipini, *Mocholopyga, Archips, Clepsis, Dicelletis, Ulodemis, Neocalyptis, Meridemis, Homona, Scotiophyes*, India, Genitalia.

INTRODUCTION

The tribe Archipini of the subfamily Tortricinae (Tortricidae) having worldwide distribution has been least attended to taxonomically in India (Meyrick, 1907, 1908, 1912, 1914, 1918, 1920, 1924, 1928). Workers like Diakonoff (1948, 1976, 1982). Obraztsov (1954, 1959, 1964, 1967) and Kawabe (1965) have dealt with the Archipini fauna from various localities in the Oriental region. In order to fill up a void in Indian context, authors have collected twenty species referable to nine genera viz., *Mocholopyga* Diakonoff, *Archips* Hübner, *Clepsis* Guenée, *Dicelletis* Meyrick, *Ulodemis* Meyrick, *Neocalyptis* Diakonoff, *Meridemis* Diakonoff, *Homona* Walker and *Scotiophyes* Diakonoff belonging to the tribe Archipini (Tortricinae) of the family Tortricidae from various localities in North-West India between 1998–2002. Besides furnishing a key to all the aforesaid genera, the genitalia of twelve previously known species and descriptive account of eight new species is dealt with in the present communication.

METHODOLOGY

In view of nocturnal behaviour of the Archipini moths, their collection was done with the help of portable light trap fitted with 125 w Mercury Vapour lamp to attract the moths. The traps were installed near the ground level amongst the bushes as the moths are generally weak fliers. In addition to this, a Mercury Vapour lamp was also hung along a white cloth sheet secured to a wall or directly over a plain white wall. Specimens were then collected singly in the small glass killing tubes. Each collected specimen was spread in the small spreading boxes after pinning it through the mid of mesothorax. The spread specimens were preserved in the insect storage boxes, fumigated with naphthalene balls. Before the specimens were preserved in the boxes, each was furnished with data such as date of collection, name of the locality, collection altitude and name of the collector etc. To prepare the permanent slides of the wings, method discussed by Common (1970) and advocated by Zimmerman (1978) has been followed. To study the external male and female genitalia, the method suggested by Robinson (1976) has been followed with slight modification. The method involves maceration of the material in potash, followed by its removal through washing and then dissection, cleaning and staining in Chlorazol Black E (1% solution in 70% alcohol). This is followed by dehydration, hardening and cleaning of the material in euparal essence or clove oil. Before mounting, the diagrams of the genitalia were drawn while the material is still in the clearing agent. This is to have a proper look of various constituent parts of the genitalia.

RESULTS AND DISCUSSION

Besides giving original reference to each taxon, complete synonymy has been listed to update the information of different Indian species. The names of the larval host plants have also been included to make the information more useful to future workers.

Tribe: Archipini

Archipini Pierce and Metcalfe, 1922, *Genitalia Group Tortricidae Lepid. Br. Is:* xxi, (as Archipsidii).

Type-genus: Archips-Hübner, 1822, *Syst.-alphab. Verz.:* 58–66.

Forewing often with costal fold in male, chorda and M-stem usually absent; in male genitalia uncus with a brush of hair below apex; transtilla often bipartite, spined above, valva with costa atrophied and membranous, sacculus strongly sclerotized, separated by a membranous central plicate disc; female genitalia with signum often dagger-shaped.

Key to the genera of the tribe Archipini

1. Forewing with all veins free, particularly R_4 and R_5 2
   -Forewing with veins R_4 and R_5 or R_3, R_4 and R_5
   stalked 4

2. Forewing with vein CuA_2 arising beyond middle,
   from two-third of discal cell. 3
   -Forewing with vein CuA_2 arising before middle,
   from anterior one-third of discal cell . . . . *Mochlopyga* **Diakonoff**

3. Abdomen with second and third tergites with promi-
   nent abdominal pits, forewing always with a costal
   fold present in male, male genitalia with transtilla
   ribbon-like, sacculus always ending in a free tooth-
   like prominence; female genitalia with ostium bursae
   and antrum broad . . . . *Archips* **Hübner**
   -Abdomen with second and third tergites without
   abdominal pits; forewing always without a costal
   fold in male; male genitalia with transtilla produced
   into dentate lobes, sacculus simple; female genitalia
   with ostium bursae and antrum rather narrow . . . . . . *Clepsis* **Guenée**

4. Forewing with veins R_4 and R_5 stalked; male geni-
   talia with uncus usually broad and clavate 5
   -Forewing with veins R_3, R_4 and R_5 stalked; male
   genitalia with uncus long and slender . . . . *Dicelletis* **Meyrick**

5. Antenna notched at base in male; male genitalia
   with gnathos arms strongly dentate beyond middle;
   female genitalia with sterigma bilobate. . . . . *Ulodemis* **Meyrick**
   -Antenna simple in male; male genitalia with
   gnathos arms smooth throughout; female genitalia
   with sterigma not bilobate 6

6. -Male genitalia with transtilla simple, ribbon-like
    continuous band; female genitalia usually with cor-
    pus bursae bearing a dagger-shaped signum........   7
    -Male genitalia with transtilla well developed, pro-
    duced into dentate lobes, the latter easily separable;
    female genitalia with corpus bursae without signum   ***Neocalyptis* Diakonoff**

7. Hindwing with veins M_3 and CuA_1 connate ....   ***Meridemis* Diakonoff**
    -Hindwing with veins M_3 and CuA_1 stalked **8**

8. Forewing with a well developed and broad costal
    fold present in male; male genitalia with uncus broad
    and clavate, gnathos arms fused apically...........   ***Homona* Walker**
    -Forewing without costal fold in male, male genitalia
    with uncus long and slender, gnathos arms fused
    beyond middle, apices free.....................   ***Scotiophyes* Diakonoff**

Mochlopyga Diakonoff

Mochlopyga Diakonoff 1955, *Veröff. Zool. St. Samml. Münch.*, **8**: 44.
Machlopyga (sic) Yasuda, 1969, *Bull. Univ. Osaka Perfect.* **21**(B): 169, 170.
Type-species: *Tortrix humana* Meyrick, 1912, *Exot. Microlepid.*, **1**: 6, by original
    designation and monotypy.

Mochlopyga humana (Meyrick)

Tortrix humana Meyrick, 1912, *Exot. Microlepid.*, **1**: 6.–1912, in Wagner, *Lepid.
    Catal.*, **10**: 27. -1913, *in* Wytsman, *Genera Insect.*, **149**: 29. Clarke, 1955, *Cat.
    type-spec. Microlepid. BMNH described by Edward Meyrick*, **1**: 163. - 1958,
    Cat. type-spec. Microlepid. BMNH described by Edward Meyrick, **3**: 240, pl.
    120, Figs. 3–3b.
Tortrix noseropis Meyrick, 1928, *Exot. Microlepid.*, **3**: 458. Clarke, 1955, *Cat. type-
    spec. Microlepid. BMNH described by Edward Meyrick*, **1**: 218. - 1958, *Cat.
    type-spec. Microlepid. BMNH described by Edward Meyrick*, **3**: 248, pl. 124,
    Figs. 1–1b.
Mochlopyga humana; Diakonoff, 1964, *Veröff. Zool. St Samml. Münch*, **8**: 44, fig. 1,
    pl. 25, figs. 5, 7–8. Yasuda, 1969, *Bull. Univ. Osaka Perfect.*, **21**(B): 169, pl. 3,
    fig. 9.
Mochlopyga khola Yasuda, 1969, *Bull. Univ. Osaka Perfect.*, **21**(B): 170, pl. I, Fig. H,
    pl. 3, Figs. 10–12.

Female genitalia (Plate-1, Fig. A): Papillae anales flat, foot-shaped; anterior apophy-
ses *longer than posterior; sterigma well developed, lamella postvaginalis in the shape
of two plates; ostium bursae narrow; antrum very small, as wide as ductus bursae;
ductus bursae long and narrow, gradually widening towards corpus bursae, cestum*

reaching beyond middle; corpus bursae globular in shape; signum single, thorn-like; ductus seminalis opening near antrum.

Male genitalia: Not Examined.

Alar expanse: Female, 20 mm.

Material examined: Uttaranchal: Dist. Dehradun; FRI, 700 m, 2.vi. 1998, 1 ♀.

Distribution: India (Sikkim, Bengal), Nepal (Diakonoff, 1976).

Larval host plant: Unknown

Remarks: Diakonoff (1955) proposed the genus *Mochlopyga* with *Tortrix humana* Meyrick as its type-species. While doing so, the morphological characters such as the labial palpi, wing venation, wing maculation and the male genitalia were taken into consideration whereas no comments were made on the female genitalia, which the author figured subsequently (Diakonoff, 1976) while dealing with the Tortricidae from Nepal. The genitalia of the present female specimen completely agree with the figure, and accordingly, the species is described as *Mochlopyga humana* (Meyrick) from North West India for the first time.

Archips Hübner

Hübner, 1822, *Syst.-alphab. Verz.*: 58–66.
Cacoecia Hübner, [1825] 1816, *Verz. bekannter Schmett.*: 388. Type-species: *Phalaena xylosteana* Linnaeus, 1758, *Syst. Nat.* (Edn 10), **1**: 531, by subsequent designation by Fernald, 1908, *Genera Tortricidae Types*: 14, 54.
Archiceps (sic) Weiss and Dickerson, 1921, *Jl. N.Y. ent. Soc.* **29**: 142.
Cacoesia (sic) Llewellyn Jones, 1939, *Proc. ent. Soc. Br. Colomb.* **35**: 25.
Archippus Freeman, 1958, *Can. Ent.*, **90** (Suppl. 7): 15. Type-species: *Tortrix packardiana* Fernald, 1886, *Bull. U.S. Dep. Agric.* (Div. Ent.) 12: 20, by original designation.
Pararchips V.I. Kuznetsov, 1970, *Ent. Obozr.*, **49**: 448. Type-species: *Ariola pulchra* Butler, 1879, *Illust. Typical Specimens Lepid. Heterocera Colln. Br. Mus.* **3**: 19, pl. 45, fig. 6, by original designation.
Type-species *Phalaena oporana* Linnaeus, 1758, *Syst. Nat.* (Edn 10), **1**: 530 by subsequent designation by Meyrick, 1913, *in* Wytsman, *Genera Insect.*, **149**: 23.

Remarks: The species of the genus *Archips* Hübner have often been described either under the genus *Tortrix* Linnaeus or *Cacoecia* Hübner, the latter besides other names such as *Archiceps* Weiss and Dickerson, *Archippus* Freeman and *Pararchips* V.I. Kuznetsov being considered as synonyms of the genus *Archips* by Razowski (1977). Prior to this, Diakonoff (1939) made a categorical remark that the genus *Cacoecia* is quite a large and difficult taxon in view of considerable sexual dimorphism shown by different species. Also, the species are highly variable in their wing maculation/pattern (Diakonoff, 1976). As such, while revising the genus *Archips*,

Razowski (1977) has mentioned that it is represented in the Palaearctic, Nearctic and the Oriental regions with forty-six, sixteen and twenty-five species from the respective region. From the Oriental region, the species i.e., *A. alcmaeonis* (Meyrick), *A. hemixantha* (Meyrick), *A. pruneticolus* (Meyrick), *A. binigrata* (Meyrick), *A. eurplintha* (Meyrick), *A. subsidiara* (Meyrick), *A. solida* (Meyrick), *A. termias* (Meyrick), *A. dispilana* (Meyrick) and *A. machlopis* (Meyrick) have been reported from India. Besides, the author has further remarked that several species of this genus appear to be endemic in some rather small territories, whereas, a few are widely distributed.

According to Tuck (1990), the genus *Archips* consists of about hundred species and ranges through the Holarctic region and the Oriental region as far east as Timor. In another observation, the author has stated that although Razowski (1977) has revised the world fauna of *Archips* he gave no illustrations of the adults besides very little material from the Oriental region. In the aforesaid background, individuals referable to six species i.e., *A. machlopsis, A. termias, A. kangraensis* sp. nov., *A. carteri* sp. nov., *A. mertias* sp. nov. and *A. pseudotermias* sp. nov. have been dealt with presently. Besides other diagnostic characters, it has been noticed that the genus *Archips* is distinct from the rest of the genera of the tribe Archipini due to the presence of dorsal abdominal pits on the second and third tergites. The genus is closely allied to *Isodemes* Diakonoff, *Allodemis* Diakonoff, *Ulodemis* Meyrick, *Chiraps* Diakonoff and Razowski, *Dynatocephala* Diakonoff, *Homona* Walker and the *Homona encausta* Meyrick species-group. All the aforesaid genera except the *H. encausta* species-group differ from the genus *Archips* in the absence of dorsal pits on the second and third abdominal tergites (Tuck, 1990). The male genitalia of all the species, presently handled, has been examined in considerable details. It has been inferred that in view of characters such as well developed uncus, simple transtilla, poorly developed costa of the valva, well developed sacculus and pistol-shaped aedeagus; these species form a natural group and thus are broadly congeneric. This is also partially confirmed on the basis of presence of a dagger-shaped signum in the corpus bursae of the female genitalia, which has been studied in three species i.e., *A. machlopis* (Meyrick), *A. termias* (Meyrick) and *A. kangraensis* sp. nov. Regarding wing venation, the veins R_4 and R_5 are never stalked but close to each other at base.

Key to the species of the genus *Archips* Hübner

1. Male genitalia with uncus broad, strongly clavate, aedeagus almost straight, coecum inconspicuous; female genitalia with ductus bursae always with cestum present, the latter long, well developed . . . . .   *machlopis* **Meyrick**

    -Male genitalia with uncus long, slender, aedeagus pistol-shaped, coecum well developed; female genitalia with ductus bursae with or without cestum

    . . . .   **2**

2. Male genitalia with uncus long, slender, pointed
    apically **3**
    -Male genitalia with uncus long, broad, blunt api-
    cally **5**

3. Forewing with veins R_4 and R_5 connate basally;
    male genitalia with aedeagus sharply bent at right an-
    gle, horizontal axis more than twice length of vertical
    axis, terminal dent at right angle to horizontal axis .   *mertias* **sp. nov.**
    -Forewing with veins R_4 and R_5 free basally; male
    genitalia with aedeagus gradually and slowly bent, if
    sharply bent, horizontal axis less than double length
    of vertical axis, terminal dent absent, if present then
    not at right angle to horizontal axis **4**

4. Forewing with median fascia not developed, hind-
    wing with veins M_3 and CuA_1 connate at base; male
    genitalia with aedeagus slowly and gradually bent at
    right angle, terminal dent absent, coecum small . . . .   *pseudotermias* **sp. nov**
    -Forewing with median fascia developed, the latter
    crescent shaped, fuscous; hindwing with veins M_3
    and CuA_1 shortly stalked at base; male genitalia with
    aedeagus sharply bent at right angle, terminal dent
    present, coecum long and well developed . . . .   *termias* **Meyrick**

5. Forewing with costal fold reaching beyond middle
    in male, ground colour ferruginous with slight dark
    suffusion in the basal half; male genitalia with aedea-
    gus long, sharply bent at right angle, horizontal axis
    more than twice length of vertical axis, outer wall
    without any carinae . . . .   *kangraensis* **sp. nov.**
    -Forewing with costal fold hardly reaching middle
    in male, ground colour yellow with uniform suffu-
    sion of ferruginous throughout; male genitalia with
    aedeagus comparatively smaller, slowly and gradu-
    ally bent, horizontal axis slightly over vertical axis,
    outer wall with numerous carinae ventrally . . . .   *carteri* **sp. nov.**

Archips machlopis (Meyrick)

Cacoecia machlopis Meyrick, 1912. *Exot. Microlepid.*, **1**: 4.
Cacoecia compacta Meyrick, 1918 *Exot. Microlepid.*, **2**: 164.
Archips compacta; Clarke, 1958: *Cat. type-spec. Microlepid. BMNH described by Edward Meyrick*, **3**: 43.
Cacoecia isocyrta Meyrick 1920, *Exot. Microlepid.*, **2**: 340.
Cacoecia seminubila Meyrick, 1930: *Annals Soc. Ent. Fr.*, **98**: 711.

Archips seminubilus; Razowski, 1977, *Act. Zool. Cracov.*, **22**(5): 127.
Cacoecia transcutata Meyrick, 1935: *Exot. Microlepid.* **4**: 569.
Archips transcutatus; Razowski, 1977, *Act. Zool. Cracov.*, **22** (5): 109.

Male genitalia (Plate-1, Figs B-C): Uncus broad, strongly clavate, rounded apically, apex finely setosed; socii absent; gnathos arms thin, gradually curve, joined and pointed distally; tegumen broad, arched; vinculum V-shaped, saccus absent; transtilla thin, slender, band-like; juxta shield-shaped; valvae symmetrical, broad, costa atrophied, weakly sclerotized, strongly arched, sacculus strongly sclerotized, broad, terminally ending in a free pointed protuberance, differentiated by a membranous plicate disc; cucullus reduced, undifferentiable; aedeagus straight, coecum almost negligible, vesica with two long needle-like cormuti; caulis extending three-fourth of aedeagus.

Female genitalia (Plate-1, Fig. D): Papillae anales flat, somewhat triangular in outline; anterior apophyses longer than posterior apophyses; ostium bursae broad; sterigma connected to anterior apophyses; antrum broad, funnel-shaped; ductus bursae long, wide, coiled, with cestum upto three-fourth proximally; corpus bursae small, rounded, signum dagger-shaped, long, narrow; ductus seminalis entering near antrum.

Alar expanse Male, 16–20 mm; Female, 19–22 mm.

Material examined

Punjab: Dist. Patiala, PUP, 250 m, 2-8.iii.1998, 3♂♂, 2♀♀, 1.v.1998, 1♂, 1♀, 12.vi.1998, 2♀♀, 26.x.1998, 1♂, 3.xi.1998, 1♂, 24.ii.1999, 1♂, 1♀, 2-25.iii.1999, 13♂♂, 2♀♀, 2-21.iv.1999, 3♂♂, 1♀, 8.viii.1999, 1♂, 1♀, 12.ix.1999, 1♂, 12.x.1999, 1♀, 4.iii.2000, 1♂. Dist. Roopnagar, YH, Roopnagar, 350 m, 14-15, vi.2000, 6♂♂. Dist. Hoshiarpur, FRH, Chohal, 400 m, 2.iii.2000, 1♀. Dist. Gurdaspur, Dunera, 700 m, 19.iii.2000, 2♂♂, 2♀♀.
Uttaranchal: Dist. Dehradhun, FRI, 700m, 2.vi.1998, 2♀♀, 21-26.iv.1999, 141♂♂, 53♀♀, 18-19.iv.2000, 58♂♂, 11♀♀; Vikasnagar, 600 m, 26.ix.1999, 1♂; Haridwar, 800 m, 27.iv.1999, 2♂♂.
Himachal Pradesh: Dist. Sirmour, Renuka Lake, 740 m, 12-14.iv.1999, 10♂♂, 1♀, 5.ix.1999, 1♂, 21.iv.2000, 1♂. Dist. Kangra, SRH, Kangra, 800 m, 12.vi.1998, 8♂♂, 2♀♀; KV, Palampur, 700 m, 25.vi.1999, 1♂; Andhretta, 900 m, 27.vi.1999, 2♂♂.

Distribution: India (Khasi Hills, Bengal), Nepal, Pakistan, China, Burma, Java, N. Vietnam, Malaysia, Sumatra, Tonkin (Robinson *et al.*, 1994).

Larval host plants: Lucerne (*Medicago* Linnaeus), orange, litchi, tea (Robinson *et al.*, 1994).

Remarks: *Archips machlopis* (Meyrick) has frequently been confused/misidentified with a closely allied species i.e., *A. micaceana* (Meyrick) (Robinson *et al.*, 1994). So much so, workers such as Diakonoff (1939) and Clarke (1958) have considered it as a synonym of the latter, whereas, Razowski (1977) has removed it from the

synonymy and considered it as a distinct species. Recently, Robinson *et al.* (1994) have clarified that the range of the species *A. micaceana* does not include India, whereas *A. machlopis* is widely distributed species, probably to be found throughout Asia, south of the Himalaya and extending into Malay Peninsula, Sumatra and Java (Tuck, 1990). Meyrick (1912) while reporting the latter species (i.e., *Cacoecia machlopis*) has given a brief description on the basis of females only, whereas, Razowski (1977) described and figured its male and female genitalia. In the present study, three hundred and forty-one specimens (two hundred and fifty-eight males, eighty-three females) have been identified as belonging to the species *machlopis* of the genus *Archips*. Morphologically, it can be separated from its closely allied species *A. termias* (Meyrick) on the basis of pale tornal area in the hindwing, which extends as an elongate patch towards apex of the wing in former species, whereas, it is diffused in all directions in the latter. As evident from the material examined, this is the most common species being reported from as low as 250 m (Patiala) to 800 m (Kangra) from the Siwaliks in North West India.

Besides being sexually dimorphic, the species has been found to be highly variable morphologically too. Even the individuals collected from the same locality showed certain variations. Due to variations shown by this species, the variable individuals have frequently been given a new name and hence a long list of synonymy. Further, while dealing with this species from Malaysia and Indonesia, Tuck (1990) has added two new synonyms i.e., *Cacoecia seminubila* Meyrick (Tonkin, Vietnam, China, India (Bengal)) and *Cacoecia transcutata* Meyrick (Indonesia) under this species. In view of this, a series of twenty dissections of the male and eight of the female genitalia have been made to establish the conspecific nature of all such variable individuals collected from the Siwaliks in North West India. The species is quite conspicuous in having a very broad and strongly clavate uncus and more or less straight aedeagus with reduced coecum in the male genitalia. Subject to collection of the material from other parts of the country, it is being thoroughly investigated that the identity of this species can only be established after examination of its male genitalia. In view of existing confusion with closely allied species, *A. machlopis* is being redescribed in order to make its position somewhat more clear from the area, under reference.

Archips mertias sp. nov.

Male: Alar expanse: 14–16 mm. Vertex rough scaled; frons smooth, white scaled; labial palpus small, porrect, pale brownish, second segment with whitish scales; thorax brownish; forewing with costa arched beyond middle, then concave, apex rounded, termen almost straight, rounded beneath, tornus obtuse, anal margin straight, strongly arched basally, costal fold long, reaching exactly middle, two-third blackish basally, remaining creamy-whitish, ground colour of wing yellowish, basal and subbasal fascia irregular, fuscous, median fascia defused, darker towards anal margin, preapical spot semi-oval, immediately continuous after costal fold, reddish brown, fringes black at apex, reddish brown at termen, becoming light posteriorly, pale whitish at tornus; hindwing quadrate, anal margin produced, light fuscous except apex, latter pale

yellow, costa white; legs whitish-brown; abdomen light brown, with two pairs of abdominal pits on second and third tergites.

Wing venation (Plate-2, Figs B–C): Forewing with Sc ending at basal one-third of costa, R_1 originating before middle of cell, ending at almost middle of costa, $R_1 R_2$ and R_3 arising almost at equal distance, R_4 and R_5 connate, R_4 to costa, R_5 to termen, M_1 and M_2 almost parallel to each other, M_2 closer to M_3 at base, CuA_1 originating before angle of cell, CuA_2 arising beyond middle of cell, CuP vestigial, visible only distally, 1A + 2A forked at base; hindwing with $Sc+R_1$ ending at three-fourth of costa, Rs and M_1 short stalked, M_2 coming close to M_3 at base, M_3 and CuA_1 connate, arising from angle of cell, CuA_2 arising slightly beyond middle of cell, CuP visible only in the distal half, 1A+2A forked at base, 3A present.

Male genitalia (Plate-2, Figs D–E): Uncus long, thin, slender, gradually curved, tip pointed; socii absent; arms of gnathos thin, jointed distally, tip pointed; tegumen broad and flat, slightly arched; vinculum thin, U-shaped, without saccus; transtilla band-like, weak; juxta plate-like; valva broad, costa atrophied, arched, convex up to four-fifth, then slightly concave, sacculus well sclerotized, terminal part ending in a small free protuberance, dorsal margin delimited by a membranous central plicate disc, latter as long as sacculus; aedeagus pistol-shaped, strongly and sharply bent at right angle, horizontal axis double as long vertical, lower lip pointed, terminal dent at right angle to long axis, vesica without cornuti;caulis reaching three-fourth of long axis of aedeagus.

Material examined:
Holotype:	Himachal Pradesh: Dist. Kangra; Dharmshala, 1200 m, 16.vi.1998, ♂.
Paratypes:	Himachal Pradesh: Dist. Kangra; Dharmshala, 1200 m, 16.vi.1998, 3♂♂, 17.vi.1998, 1♂.

Larval host plant: Unknown

Remarks: In respect of wing pattern of the male and shape of the uncus in the male genitalia, the species *A. mertias* sp. nov. is closely allied to *A. termias* (Meyrick). However in the former species, the veins R_4 and R_5 in the forewing are connate whereas, these are free at base in the latter. Also both the species differ from each other in shape of the aedeagus which have horizontal axis more than twice length of vertical axis and terminal dent at right angle to horizontal axis in *mertias* but horizontal axis less than double length of vertical axis and terminal dent not at right angle to horizontal axis in *termias*.

Etymology: The name of the species as *Archips mertias* sp. nov. is an anagram of the specific epithet *termias* of the genus *Archips* Hübner.

Archips pseudotermias **sp. nov.**

Male: Alar expanse: 23 mm. Vertex pale ochreous, rough scaled; frons light reddish brown; antenna filiform; labial palpus light reddish brown, 1.3 times diameter of

eye, third segment short and porrect; thorax light brown, with a slight tinge of purple; forewing with costa gently arched throughout, apex rounded, termen straight to middle, rounded beneath, tornus obtuse, anal margin straight, arched basally, ground colour pale yellow, uniformly reddish brown, with slight tinge of purple, costal fold moderate, almost reaching middle, dark reddish brown, with a dominating tinge of purple; hindwing somewhat quadrate, light blackish tinge, hind tibia normal; abdomen blackish brown, two pairs of abdominal pits on second and third tergites.

Wing venation (Plate-3, Figs. B–C): Forewing with Sc ending before middle of costa, R_1 ending beyond middle of costa, R_2 nearer to R_3 than R_1, R_2, R_3 and R_4 at equal distance, R_4 and R_5 free, R_4 to costa, R_5 to termen, M_1 nearer R_5 than M_2, M_2 nearer M_3 than M_1, M_3 close to M_2 at base, CuA_1 originating well before lower angle of cell, CuA_2 arising at middle of cell, CuP visible only distally, 1A+2A forked at base; hindwing with Sc+R_1 ending at three-fourth of costa, Rs and M_1 approximated at base, M_2 close to M_3 at base, M_3 and CuA_1 connate at lower angle of cell, CuA_2 arising slightly beyond middle of cell, CuP visible only distally, 1A+2A forked, 3A present, diverging terminally.

Male genitalia (Plate-3, Figs D–E): Uncus long, thin, slender, gradually curved, pointed distally; socii absent; gnathos arms weak, joined distally, with tip pointed; tegumen broad, slightly arched; vinculum thin, U-shaped, saccus absent; transtilla band-like, weak; valva broad, costa atrophied, slightly arched, sacculus well sclerotized, dorsal margin separated by a broad membranous central plicate disc, terminally ending in a very small free protuberance, cucullus reduced, undifferentiable; aedeagus pistol-shaped, slowly and gradually bent at right angle, horizontal axis 1.5 times that of ventral axis, lower lip pointed, terminal dent absent, vesica with two needle-like cornuti, caulis reaching middle of horizontal axis.

Female genitalia: Not examined.

Material examined: Holotype: Punjab: Dist. Patiala; PUP, 250 m, 30.viii.1999, ♂.

Larval host plant: Unknown

Remarks: From the wing pattern, *Archips pseudotermias* sp. nov. appears to be closely allied to *A. carteri* sp. nov. but their male genitalia are drastically different from each other. Having long and slender uncus, the former species goes near to *A. termias* Meyrick and *A. mertias* sp. nov. but can easily be separated from them on the basis of wing pattern as well as size and shape of the aedeagus and difference in the wing venation as mentioned in the key above.

Etymology: The name of the species (*Archips pseudotermias* sp. nov.) is derived from the specific epithet *termias* of the genus *Archips* Hübner.

Archips termias (Meyrick)

Cacoecia termias Meyrick, 1918, *Exot. Microlepid.*, **2**: 164. - 1920, *Exot. Microlepid.*, **2**: 340. - 1937, *in* Caradja and Meyrick, *Iris*, **51**: 173. Fletcher, 1932, *Imp. Council Agric. Res., Sci. Monogr.*, **2**: 15. Clarke, 1958, *Cat. type-spec., Microlepid.*

BMNH described by Edward Meyrick, **3**: 51, pl. 25, fig. 3-3b. Obrazstov, 1955,
Tijdschr. Ent. **97**: 206. Yasuda, 1969, *Bull. Univ. Osaka Pref.*, **21**(B): 168, pl. 1
fig. A. Diakonoff, 1971, *Veröff. Zool. Staatssammlung München*, **15**: 170.

Cacoecia pomivora Meyrick, 1920, *Exot. Microlepid.*, **2**: 340. Fletcher, 1932, *Imp.*
Council Agric. Res., Sci. Monogr., **2**: 15. Diakonof, 1939, *Rec. Indian Mus.*,
41: 233. Clarke, 1955, *Cat. type-spec. Microlepid. BMNH described by Edward*
Meyrick, **1**: 254.

Archips pomivora, Clarke, 1958, *Cat. type-spec. Microlepid. BMNH described by*
Edward Meyrick, **3**: 47, pl. 23 fig. 2-2b.

Cacoecia sarcostega Meyrick, 1924, *Exot. Microlepid.*, **3**: 107. Clarke, 1955, *Cat.*
type-spec. Microlepid. BMNH described by Edward Meyrick, **1**: 276.

Archips sarcostega; Clarke, 1958, *Cat. type-spec. Microlepid. BMNH described by*
Edward Meyrick, **3**: 47, pl. 25 fig. 4-4a.

Male genitalia (Plate-4, Figs A–B): Uncus long, slender, pointed apically; socii
absent, arms of gnathos weak, gradually curved, joined distally to a pointed tip;
tegumen broad, arched; transtilla thin, slender, band-like; vinculum v-shaped; saccus
absent; transtilla band-like, slender; juxta shield-shaped; valvae symmetrical, broad,
costa atrophied, weakly sclerotized, strongly arched, sacculus broad, terminally
ending in a free pointed protuberance, differentiated by a membranous plicate disc;
cucullus reduced, undifferentiable; aedeagus pistol-shaped, strongly curved at right
angle, horizontal axis slightly longer than vertical axis, lower lip obliquely pointed,
coecum quite large, vesica armed with two long needle-like cornuti; caulis extending
upto middle of aedeagus.

Female genitalia (Plate-4, Fig. C): Papillae anales flat, large, bean-shaped; posterior
apophyses shorter than anterior apophyses; ostium bursae broad; sterigma connected
to anterior apophyses; antrum broad, reversed bell-shaped; ductus bursae long, narrow,
coiled, cestum absent; corpus bursae small, rounded, signum dagger-shaped.

**Alar expanse:** Male, 17–20 mm. Female, 19–22 mm.

Material examined:

Himachal Pradesh: Dist. Solan; UHF, Nauni, 1360 m, 10.ix.98, 17♂♂, 7♀♀.
20.v.1999, 2♂♂, 13-14.ix.1999, 30♂♂, 14♀♀, 5.iv.2000, 1♂, Dharampur,
1500 m, 16.vi.1999, 16♂♂, 5♀♀.

Distribution: India, Nepal, Afghanistan, North East Burma (Razowski, 1977).

Larval host plants: Apple, Rose, *Acacia arabica* (Razowski, 1977).

Remarks: Meyrick (1918, 1920, 1924) while giving three new names i.e., *Cacoecia*
termias (Shillong, Assam), *C. pomivora* (Kumaon, Ramgarh) and *C. sarcostega*
(Kumaon, Muktesar) for the individuals collected from the respective localities in
India did not designate the holotypes for these species. In order to plug this void,
Clarke (1958) designated the lectotypes of all the three species subsequently as
per requirement under ICZN. During the course of present studies, a large sample

Plate 1

Plate 2
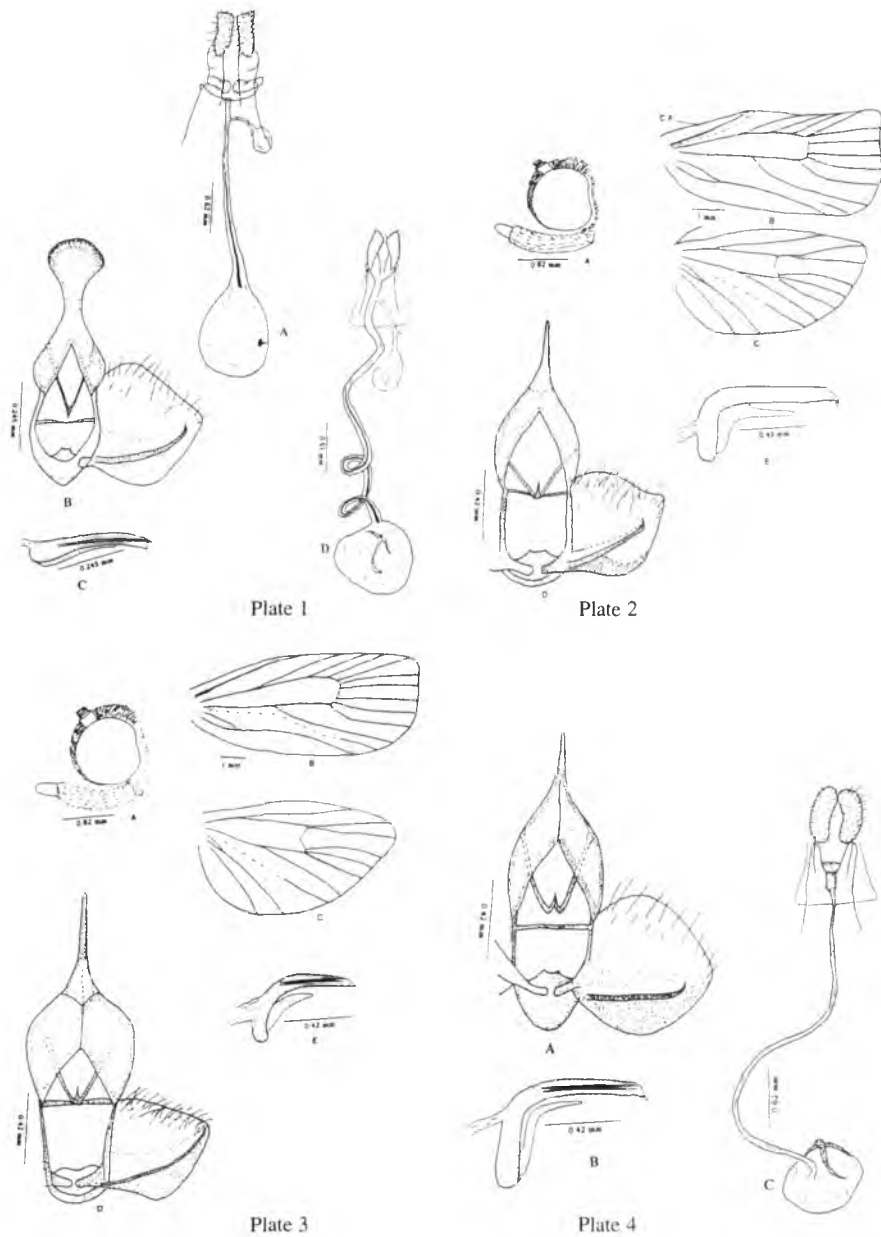
Plate 3

Plate 4

PLATES 1–4. Fig. 1A: *Mochlopyga humana* (Meyrick): A. Female genitalia: Ventral view. Figs. B–D: *Archips machlopis* (Meyrick): B. Male genitalia: Ventral view, C. Aedeagus, D. Female genitalia: Ventral view. Figs. 2A–E: *Archips mertias* sp. nov.: A. Labial palpus, B. Forewing venation, C. Hindwing venation, D. Male genitalia: Ventral view, E. Aedeagus. Figs. 3A–E: *Archips pseudotermias* sp. nov.: A. Labial palpus, B. Forewing venation, C. Hindwing venation, D. Male genitalia: Ventral view, E. Aedeagus. Figs. 4A–C: *Archips termias* (Meyrick): A. Male genitalia: Ventral view, B. Aedeagus, C. Female genitalia Ventral view.

comprising ninety-two examples has been examined and on the basis of presence of pairs of abdominal pits and position of the veins R_4 and R_5 of the forewing, it has been found to belong to the genus *Archips* Hübner. Like *Archips machlopis* (Meyrick), various individuals of this sample reveal sexual dimorphism, as well as, some other variations in either sex. Even the individuals collected from the same locality show these variations. In order to rule out this population confusion, eighteen males (twelve from Nauni, six from Dharampur (HP)) and eight females (five from Nauni and three from Dharampur) were dissected and the whole sample belonging to the aforesaid two localities was found to be conspecific.

Diakonoff (1976) while working on the superfamily Tortricoidea from Nepal has examined the lectotypes (designated by Clarke, 1958) of the aforesaid three species and found out that *Archips pomivora* (Meyrick) and *A. sarcostega* (Meyrick) were the synonyms of the species *A. termias* (Meyrick). In the following year, Razowski (1977) also examined the same material at NHM, London and confirmed the synonymy proposed by Diakonoff (1976). These lectotypes (*A. termias*, male, Assam, Shillong, 5,000 feet, 10.16, slide no. JFGC-6812; *A. pomivora*, male Himalaya, Kumaon, Ramgarh, 9.19, slide no JFGC-6810; *A. sarcostega*, male Kumaon, Muktesar, 7,300 feet, 4.23, slide no. JFGC-6821) have also been personally examined and the species identified as *A. termias* (Meyrick). This species is the second most common species of the genus *Archips* Hübner after *A. machlopis* (Meyrick) in North West India. Like *A. machlopis*, it is being suggested that the identification of this species can be ensured only after an examination of the male and the female genitalia of different individuals.

Archips kangraensis sp. nov.

Male: Alar expanse: 18–20 mm. Head and thorax dark ochreous with prominent tinge of black; vertex dark ochreous, frons darker than vertex with a tinge of black and stripes of white scales; labial palpus small, 1.3 times diameter of eye, dark ochreous with, almost porrect, third segment small; forewing with costa moderately arched basally, then straight, apex rounded, termed slightly oblique, tornus obtuse, anal margin straight, arched basally, costal fold narrow, reaching beyond middle, forewing colour dark ferruginous throughout, basal half comparatively darker, costal fold dark fuscous; hindwing quadrate, light ochreous throughout, legs pale ochreous, hind tibia normal; abdomen slightly darker, with two pairs of abdominal pits on second and third tergites.

Female: Alar expanse: 18–20 mm. Forewing apex prominently produced, termen slightly concave below apex, oblique and rounded beneath, head thorax and wings relatively lighter than male, more prominence of yellowish, remaining same as in male.

Wing venation (Plate-5, Figs B–C): Forewing with Sc ending at two-fifth of costa; R_1 arising before middle of cell, ending at almost middle of costa; R_2 nearer to R_3 than R_1; R_2, R_3 and R_4 at equal distance, R_4 and R_5 separate, R_4 to costa, R_5 to termen, M_1 nearer R_5 than M_2; M_2 nearer M_3 than M_1, M_3 closer to M_2 at base, CuA_1 arising before end of cell, CuA_2 arising almost in middle of cell, CuP visible only at tip,

1A+2A forked at base; hindwing with Sc+R_1 ending at three-fourth of costa; R_5 and M_1 short stalked, M_2 close to M_3 at base, M_3 and CuA_1 connate, CuA_2 arising beyond middle of cell, CuP visible only at distal one-third, 1A+2A forked at base, sinuate, 3A present.

Male genitalia (Plate-5, Figs D–E): Uncus long, moderately broad, apically flat; socii absent, gnathos arms thin bent beyond middle, jointed distally to form a pointed; tegumen broad, flat, slightly arched; transtilla band-like, weak; vinculum thin, U-shaped, saccus absent; valva broad, costa membranous, convex basally, concave in middle, sacculus well-sclerotized, terminal part ending in a small free protuberance, cucullus undifferentiable, central plicate disc narrow, as long as sacculus; aedeagus strongly and sharply bent at right angle, horizontal axis more than double as long as vertical axis, lower lip pointed, terminal dent absent, vesica without cornuti; caulis short, extending before middle.

Female genitalia (Plate-5, Fig. F): Papillae anales flat, large; anterior apophyses longer than posterior apophyses; sterigma joined to anterior apophyses; ostium bursae broad; antrum broad, ductus bursae thin and long, cestum reduced, reaching one-fourth of ductus bursae, corpus bursae ovoid, signum dagger-shaped, large.

Material examined:

    Holotype   :   Himachal Pradesh: Dist. Kangra; SRH, Kangra, 800 m,
                    12.vi.1998, ♂.
    Paratypes   :   Himachal Pradesh: Dist. Kangra: SRH, Kangra, 800 m,
                    12.vi.1998, 2♂♂, 2♀.

Larval host plant: Unknown

Remarks: *Archips kangraensis* is a distinct species from all the known species reported from different parts of the world (Freeman, 1958; Clarke, 1958; Diakonoff, 1976, 1982; Razowski, 1977; Tuck, 1990). The examination of the male genitalia shows that the aedeagus, which is strongly and sharply bent at right angle is quite species specific and uncus is long and broad with its tip flat. Though the species, under reference, is broadly allied to *A. pruneticolus* (Meyrick), *A. termias* (Meyrick) (India), *A. limatus* Razowski (China) and *A. endoi* Yasuda (Japan) but the length of the horizontal axis as compared to vertical axis, which is double in this species makes it different from thee already known species. Further, out of all these species, it is closer to an Indian species i.e., *A. termias* (Meyrick) in respect of overall size and shape of the valva in the male genitalia. However, it can be distinguished from it in the shape of the uncus, which is slender with pointed tip in *termias*. On the basis of shape of the uncus, this species goes somewhat nearer to *A. carteri* sp. nov., but differ from it in shape of the aedeagus.

Etymology: The species is named after its type-locality i.e., Kangra (Himachal Pradesh, 800 m), a valley in the foothills of Dhauladhar Mountains.

Archips carteri **sp. nov.**

Male: Alar expanse: 18 mm. Vertex rough scaled; frons smooth; labial palpus rusty red brown, 1.2 times diameter of eyes, slightly ascending, third segment small; antenna filiform; thorax ferruginous dorsally; forewing with costa gently arched beyond middle, then straight, apex rounded, termen straight to middle, rounded beneath, tornus obtuse, anal margin straight, arched basally, costal fold narrow, reaching almost middle, ground colour uniformly yellowish ferruginous; hindwing quadrate, light fuscous uniformly throughout except costa, the latter pale, under surface of both wings greyish brown except cost, the latter light reddish brown; legs pale ochreous; abdomen blackish brown dorsally, two pairs of abdominal pits on second and third segment.

Wing venation (Plate-6, Figs B–C) Forewing with Sc ending at middle of costa, R_1 arising from almost middle of cell, R_2 slightly closer to R_3 than R_1, R_2, R_3 and R_4 at equal distance, R_4 and R_5 separate, coming closer at base, M_2 and M_3 almost parallel, M_3 close to CuA_1 at base, CuA_1 arising well before end of cell, CuA_2 arising slightly beyond middle of cell, *Cu*P vestigial, visible only terminally, $1A+2A$ forked at base; hindwing with $Sc+R_1$ ending at three-fourth of costa, R_5 and M_1 short stalked, M_2 closer to M_3 at base, M_3 and CuA_1 connate at lower angle of cell, CuA_2 arising slightly beyond middle of cell, CuP visible only distally, $1A+2A$ forked at base, 3A present, abruptly diverging at end.

Male genitalia (Plate-6, Figs D–E) Uncus long, moderately broad, tip flat; socii absent, gnathos arms thin, joined beyond middle to distal end to end in pointed top; tegumen broad, flat, slightly arched; vinculum thin, U-shaped, saccus wanting; transtilla band-like, weak; juxta plate-like, small; valva broad, costa membranous, sinuate, sacculus well sclerotized, terminally ending as a free protuberance slightly before apex, cucullus not distinguished, central licate disc moderately broad; aedeagus relatively small, gradually bent at right angle, horizontal axis slightly over as long vertical, outer surface with numerous carinae ventrally, vesica beset with two long needle-like cornuti, lower lip pointed, terminal dent absent, caulis extending slightly beyond middle of aedeagus.

Female genitalia: Not examined.

Material examined:
  Holotype : Himachal Pradesh: Dist. Kangra; KV, Palampur, 700 m, 24.vi.1999, ♂.
  Paratype : Himachal Pradesh: Dist. Kangra; KV, Palampur, 700 m, 25.vi.1999, 1♂,

Larval host plant: Unknown

Remarks: On the basis of shape of the uncus and the aedeagus in the male genitalia, this species could neither be identified from the NHM, London nor from relevant literature (Clarke, 1958; Freeman, 1958; Diakonoff, 1976, 1982; Razowski, 1977; Tuck, 1990). Accordingly, it is named as *Archips carteri* sp. nov. It is allied to *A.*

kangraensis sp. nov. as far as shape of the uncus is concerned. However, it can be easily distinguished on the basis of size and shape of the aedeagus, which is much smaller, gradually bent almost in the middle, with outer margin carrying numerous fine carinae ventrally in the former and long and sharply bent before middle and is without carinae in the latter species.

Etymology: The species name is proposed as *Archips carteri* sp. nov. after the name of David Carter, Incharge, Microlepidoptera section in the Natural History Museum, London.

Clepsis **Guenée**

Guenée, 1845, *Annals. Soc. Ent. Fr.*, **3**(2): 168.

Smicrotes Clemens, 1860, *Proc. Acad. Nat. Sci. Philad.*, **1860**: 355. Type-species:
      Smicrotes peritana Clemens, 1860, *ibidem*, **1860**: 356, by monotypy.

Type-species: *Tortrix senecionama* Hübner, [1819], *Samml. Eur. Schmet.*, **7**: pl. 42,
      Fig. 263.

Remarks: Guenée (1845) proposed the genus *clepsis* with *Tortrix rusticana* Hübner [1799] sensu Treitschke, 1830 (= *Tortrix senecionana* Hübner [1819]) as its type-species. Out of these, which is a true type-species of this genus is yet a confusion, as Razowski (1977) has stated that *Tortrix rusticana* Treitschke (= *T. halbolana* Frölich) is the type-species. However, Bradley (1972) has treated *rusticana* sensu Treitschke as a misidentification of a species that should have been naked as *Tortrix senecionana* Hübner. As per Article 70 (B) of the ICZN (Edn. 3), such a case of a misidentified type-species is to be referred to the Commission to designate as the type-species whichever nominal species in his judgment best serve stability and universality of the nomenclature. In view of this, Nye and Fletcher (1991) have already expressed that the Commission be asked to designate the correct type-species of the genus *Clepsis* Guenée. Under these circumstances, a clarification was sought from the ICZN and in this regard Mr. Philip Tubbs state, 'this case has not been referred to the Commission.Under Article 70.3 of the code (Edn 4), you yourself can designate *T. senecionana* as the type-species of *Clepsis*, or, if this would be better for stability, you could designate the true *T. rusticana* Hübner (*T. rusticana* sensu Treitschke is not an available name of a species, and so can't denote a type-species). Your designation would then be binding on future authors. This action was not possible under previous editions of the Code'. Accordingly, *Tortrix senecionana* Hübner is designed as the type-species of the genus, under reference, during the course of present studies.

Further, in the present investigations, three species i.e., *Clepsis tricensa* (Meyrick), *C. melissa* (Meyrick) and *C. neomelissa* sp. nov. have been identified under the genus *Clepsis* (Clarke, 1958; Freeman, 1958; Kawabe, 1965; Diakonoff, 1976). It may also be noted that the three species are congeneric on the basis of their male genitalic characters such as that the uncus is shorter and broad and broadly attached to the tegumen. The transtilla is almost or completely separated into two dentate and clavate lobes (labis). The sacculus region of the valva is strongly sclerotized.

Key to the species of the genus *Clepsis* Guenée

1. Forewing with two black spots on costal margin,
    first before middle (median fascia) expanded, long,
    anterior margin straight, posterior concave, reach-
    ing upto middle of wing, subapical or preapical fas-
    cia semi-spherical; male genitalia with valva broad,
    more or less oval, cucullus not differentiated, aedea-
    gus broad, anteriorly narrowed; female genitalia with
    ductus bursae without cestum . . . .   *tricensa* **Meyrick**
    -Forewing without any spot on costal margin, median
    and subapical fascia represented by light yellowish-
    ochreous patches, median fascia reaching anal mar-
    gin; male genitalia with valva long, slender, cucul-
    lus well differentiated, inner surface densely hairy,
    aedeagus thin and slender, female genitalia with duc-
    tus bursae having well developed cestum **2**

2. Male genitalia with uncus broad apically, straight,
    valva with cucullus narrower than sacculus, gnathos
    arms sharply bent towards inner side in middle,
    aedeagus uniformly broad throughout, vesica armed
    with two long needle-like deciduous cornuti; female
    genitalia with cestum as long as ductus bursae . . . . .   *melissa* **Meyrick**
    -Male genitalia with uncus round, pointed apically,
    valva with cucullus somewhat broader than sacculus,
    gnathos arms gradually curved throughout, aedeagus
    slightly narrower posteriorly, vesica without cornuti;
    female genitalia with cestum reaching middle of
    ductus bursae . . . .   *neomelissa* **sp. nov.**

Clepsis tricensa (Meyrick)

Tortrix tricensa Meyrick, 1912, *Exot. Microlepid.*, **1**: 6. - 1912, *in* Wagner, *Lepid.*
    Catal., **10**: 30. - 1913, *in* Wytsman, *Genera Insect.*, **149**: 33. Clarke, 1955, *Cat.*
    type-spec. Microlepid. BMNH described by Edward Meyrick, **1**: 315. - 1958,
    Cat. type-spec. Microlepid. BMNH described by Edward Meyrick, **3**: 256, pl.
    128. figs. 3-3b.
Clepsis tricensa; Kawabe, 1965, *Kontyû*, **33**: 462.
Neocalyptis tricensa; Diakonoff, 1976, *Zool. Verh. Leiden*, **144**: 99.

Male genitalia (Plate-7, Figs A–B): Uncus small, moderately broad, broader at base,
gradually narrowing towards apex, apex rounded; socii ill-defined; gnathos arms thin,
long, joined beyond middle, pointed apically; tegumen moderately broad, shoulders

produced; vinculum thin, U-shaped, saccus absent; transtilla produced into lobes (labis), the latter dentate dorsally, both lobes loosely joined, easily separable; valva broad, rounded, costa arched, sacculus well sclerotized, narrow long, as long as valva, central plicate disc narrow, rest of the valva less sclerotized, uniform throughout, cucullus inconspicuous; aedeagus long, broad, slightly curved medially, vesica bare, without cornuti.

Female genitalia (Plate-7, Fig. C): Papillae anales flat, foot-shaped; anterior apophyses longer than posterior apophyses; sterigma connected with anterior apophyses; ostium bursae broad; antrum cup-shaped, broader than ductus bursae; ductus bursae moderately long, narrow towards ostium bursae, gradually widening towards corpus bursae, entrance into corpus bursae almost as wide as corpus bursae; ductus seminalis entering at posterior two-third of ductus bursae, corpus bursae globular in shape, signum dagger-shaped, long axis of the dagger strongly curved, sickle-shaped, with large head.

Alar expanse: 14–17 mm.

Material examined:

Himachal Pradesh: Dist. Solan; Dharmpur, 1500 m, 16.vii.1999, 2♂♂, 6.iv.2000, 1♀; UHF, Nauni, 11.ix.1999, 1♀
Distribution: India (Assam), Japan, Nepal (Diakonoff, 1976)

Larval host plant: Unknown

Remarks: Meyrick (1912) reported the species *tricensa* as a new species under the genus *Trortrix* Linnaeus from Assam. A male specimen dated '.3.1906' from the latter locality was designated at its lectotype by Clarke (1958) because the holotype was not designated by Meyrick (*loc. cit.*). Kawabe (1965) compared a sample of Japanese representatives with the type specimens of *Tortrix* lying on the collection of NHM, London and identified it as *Tortrix tricensa* Meyrick and proposed a new combination as *Clepsis tricensa* (Meyrics). Somehow or the other, without assigning any reason, Diakonoff (1976) too proposed a new combination of this species as *Neocalyptis tricensa* (Meyrick). In the present studies, a sample collected from the Siwaliks in North West India has been compared with the lectotype in the NHM, London, besides consultation of relevant literature in the context (Clarke, 1958; Kawabe, 1965; Diakonoff, 1976). Because the veins R_4 and R_5 of the forewing in this species are free, it can only belong to the genus *Clepsis* Guenée and not *Neocalyptis* Diakonoff, which always have the veins R_4 and R_5 stalked. Therefore, this species fails to conform to the characterization of the latter genus, as proposed by Diakonoff (1976). In other words, besides wing venation, structure of the uncus in the male genitalia also corroborates that the species be kept in the genus *Clepsis* and not *Neocalyptis*. Accordingly, the species is redescribed as *Clepsis tricensa* (Meyrick), as has also been hinted earlier by Kawabe (1965).

Clepsis melissa (Meyrick)

Capua melissa Meyrick, 1908, *J. Bombay, Nat. Hist. Soc.*, **18**: 613. - 1912, *in* Wagner, *Lepid. Catal.*, **10**: 9. - 1913, *in* Wytsman, *Genera Insect.*, **149**: 14. - 1937, *in* Caradja and Meyrick, *Iris*, **51**: 172. Clarke, 1955, *Cat. type-spec. Microlepid. BMNH described by Edward Meyrick*, **1**: 201. - 1958, *Cat. type-spec. Microlepid. BMNH described by Edward Meyrick*, **3**: 72, pl. 36, figs. I-Ib. Obraztsov, 1955, *Tijdschr. Ent.*, **98**: 224.

Capua epiclintes Meyrick, 1928, *Exot. Microlepid.*, **3**: 452. Clarke, 1955, *Cat. type-spec. Microlepid, BMNH described by Edward Meyrick*, **1**: 128. - 1958, *Cat. type-spec. Microlepid. BMNH described by Edward Meyrick*, **3**: 64, pl. 34 figs. 2-2b.

Male genitalia (Plate-7, Figs D–E): Uncus small, broad, much broader at base, gradually narrowing towards apex, the latter rounded; socii ill-defined; tuba analis absent; gnathos arms broad, abruptly bent in middle towards inner side, joined beyond middle to apex, distally rounded; tegumen broad, hood-shaped; vinculum reduced; transtilla produced into small dentate lobes (labis), lobes loosely joined medially, easily separable; juxta plate-like; valva long, narrow, costa straight, membranous, sacculus well sclerotized, broader at base, gradually narrowing distally, differentiable by a narrow central plicate disc, cucullus narrow, with dense hair; aedeagus moderately long, slightly curved medially, vesica with two long needle-like cornuti.

Female genitalia (Plate-7, Fig. F): Papillae anales flat; posterior apophyses shorter than anterior apophyses; sterigma well developed, attached to anterior apophyses; ostium bursae narrow; antrum narrow, slightly wider that ductus bursae; ductus bursae moderately long in size, straight, gradually widening towards corpus bursae, cestum as long as ductus bursae, reaching near antrum; corpus bursae small, globular in shape; signum dagger-shaped, all arms of dagger almost of equal size, ductus seminalis entering near antrum.

Alar expanse: 14–17 mm.

Material examined:

Himachal Pradesh: Dist. Solan; UHF, Nauni, 10-14.ix.1998, 9♂♂, 11♀♀, Dharampur, 1500 m, 31.v.1999, 1♂, 16.vi.1999, 9♂♂, 4♀♀, 6.iv.2000, 2♂♂.

Distribution: India (Assam, Bengal) Tibet, China, Nepal (Diakonoff, 1976).

Larval host plant: Unknown

Remarks: *Clepsis melissa* (Meyrick) is quite common in the Siwaliks in North West India, as evident from the survey work undertaken presently. Though there are no apparent variations in the individuals belonging to either sex, yet a series of ten males (five from Nauni, five from Dharampur) and five females (three from Nauni, two from Dharampur) were dissected to ensure that it may not represent a sibling

species. Besides description, (Meyrick, 1908), the male genitalia completely conforms to the photograph given by Clarke (1958) and Diakonoff (1976). However, it need to be pointed out here that the species, under reference, does not show any striking sexual dimorphism, which has erroneously been reported by Diakonoff (*loc. cit.*). Even, Meyrick (*loc. cit.*) did not mention anything about the sexual dimorphism, when he named this species as new from Assam on the basis of five male and female individuals. In India, besides Assam (North East India), the species, under reference, has also been recorded under another name i.e., *Capua epiclintes* Meyrick from Bengal, which has been synonymized by Diakonoff (*loc. cit.*) after examination of the lectotypes in the NHM, London.

Clepsis neomelissa sp. nov.

Male, Female: Alar expanse: 14-17 mm. Vertex and frons yellowish ochreous; labial palpus porrect, moderate in size, almost two times diameter of eye, second segment with scales on upper side, third segment minute, only tip visible; thorax yellowish ochreous; forewing with costa gently arched before middle, remaining almost straight, apex somewhat produced, termen oblique, tornus obtuse, anal margin straight, uniformly covered with whitish ochreous scales, basal and subbasal fascia ill-defined, median fascia starting slightly before middle, remaining oblique towards anal margin, yellowish ochreous, darker and turning black toward anal margin, proximal margin demarcated by an oblique silvery white line, distal margin ill-defined, subapical spot semi-oval, fringes darker and shorter at apex, lighter and longer towards tornus; hindwing quadrate, silvery whitish throughout, margins slightly darker, fringes with double row of cilia, the latter with base dark grey, remaining silvery white, apical cilia paler and shorter; prothoracic and mesothoracic legs dark fuscous, with yellow rings, metathoracic legs pale ochreous; abdomen dark fuscous.

Wing venation (Plate-8, Figs. B-C): Forewing with Sc slightly arched, ending well before middle of costa, R_1 arising well before middle of cell, ending slightly beyond middle of costa, R_2 nearer to R_3 than R_1, R_4 and R_5 free, coming closer at base, R_4 arising from upper angle, ending at costa, R_5 ending at termen, M_1 and M_2 parallel, M_3 bent towards M_2 at base, CuA_1 arising before lower angle, CuA_2 arising almost in the middle of cell, CuP visible distally, 1A+2A forked at base, discal cell long; hindwing with $Sc+R_1$ ending at posterior one-fifth of costa, R_s and M_1 closely approximated, R_s to costa, M_1 to termen, M_2 bent towards M_3 at base, M_3 and CuA_1 connate at lower angle of cell, CuA_2 arising slightly beyond middle of cell, 1A+2A forked at base, 3A present, slightly diverging.

Male genitalia (Plate-8, Figs. D-E): Uncus small and broad, broader at base, gradually narrowing towards tip, apex rounded; socii ill-defined; tuba analis absent; gnathos arms strong, joined medially to apex, apically round-pointed; tegumen broad, hood-shaped; vinculum reduced, U-shaped; transtilla produced into small dentate lobes (labis), lobes loosely joined medially, easily separable; juxta plate-like, small; valva long and narrow, costa membranous, straight, sacculus well sclerotized, long,

Plate 5

Plate 6
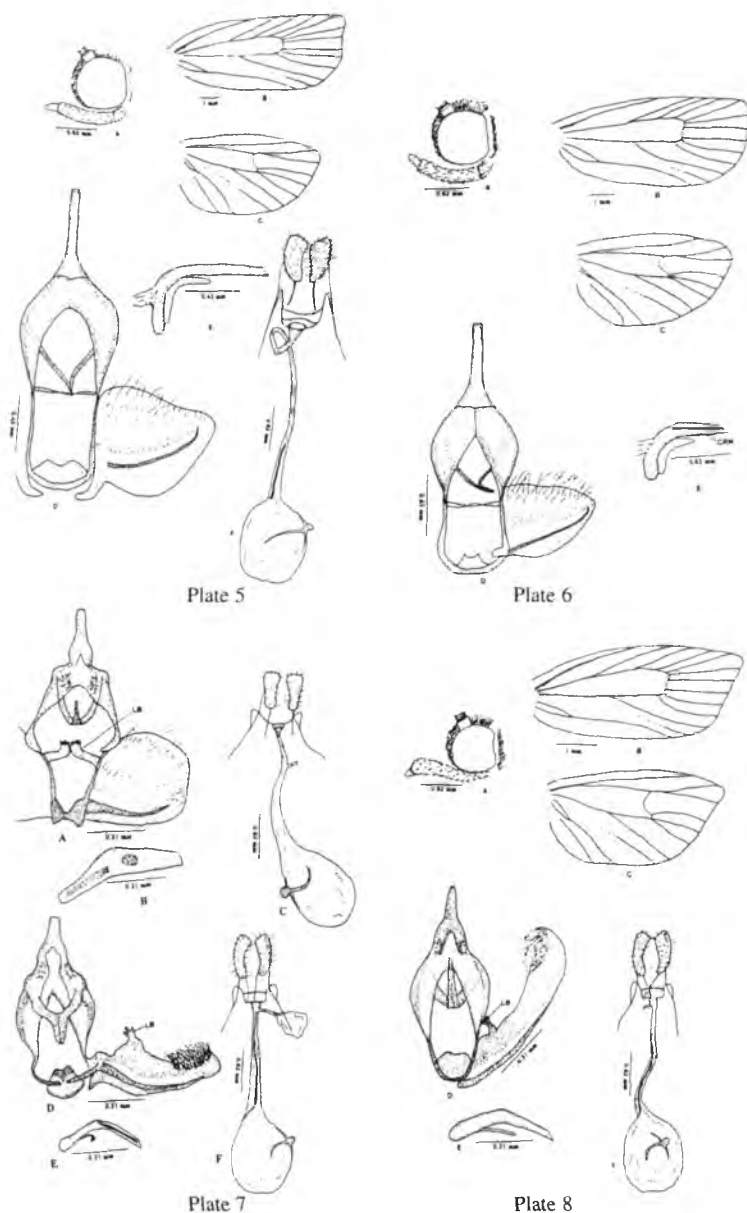
Plate 7

Plate 8

PLATES 5-8. Figs. 5A-F: *Archips kangraensis* sp. nov.: A. Labial palpus, B. Forewing venation, C. Hindwing venation, D. Male genitalia: Ventral view, E. Aedeagus, F. Female genitalia: Ventral view. Figs. 6A-E: *Archips carteri* sp. nov.: A. Labial palpus, B. Forewing venation, C. Hindwing venation, D. Male genitalia: Ventral view, E. Aedeagus. Figs. 7A-C: *Clepsis tricensa* (Meyrick): A. Male genitalia: Ventral view, B. Aedeagus, C. Female genitalia: Ventral view. Fig. D-F: *Clepsis melissa* (Meyrick): D. Male genitalia: Ventral view, E. Aedeagus, F. Female genitalia: Ventral view. Figs. 8A-F: *Clepsis neomelissa* sp. nov.: A. Labial palpus, B. Forewing venation, C. Hindwing venation, D. Male genitalia: Ventral view, E. Aedeagus, F. Female genitalia: Ventral view.

broader at base, gradually narrowing distally, central plicate disc narrow, cucullus furnished with dense hair; aedeagus moderately long, abruptly bent in middle, lower lip pointed, vesica without cornuti.

Female genitalia (Plate-8, Fig. F): Papillae anales flat; posterior apophyses shorter than anterior apophyses; sterigma well developed, attached to anterior apophyses; ostium bursae narrow, antrum narrow, slightly wider than ductus bursae; ductus bursae moderately long in size, straight, gradually widening towards corpus bursae, cestum as long as ductus bursae, reaching near antrum; corpus bursae small, globular in shape; signum dagger-shaped, all arms of dagger almost of equal sized, ductus seminalis entering near antrum.

Material examined:

Holotype   : Himachal Pradesh: Dist. Sirmour; Renuka Lake, 740 m, 12.iv.1999, ♂.

Paratypes : Himachal Pradesh: Dist. Sirmour; Renuka Lake, 740 m, 12-14.iv.1999, 2♂♂, 1♀.

Larval host plant: Unknown

Remarks:

Three males and one female individuals collected from the above localities and representing an unnamed species were sorted out under the genus *Clepsis* Guenée (Freeman, 1958). The species is named as *Clepsis neomelissa* sp. nov. The critical examination of both the male and the female genitalia shows that *C. neomelissa* differs from the closely allied species i.e., *Clepsis melissa* (Meyrick) in respect of certain male genitalic characters. The uncus is relatively less broad with its tip roundedly pointed in *C. neomelissa* and round in *C. melissa*. Also, the valva is slightly longer, cucullus well developed and the aedeagus less curved in *C. neomelissa* as compared to *C. melissa*. Moreover, the vesica is without any cornutus in *C. neomelissa*. In the female genitalia, it has been noted that the cestum reaches only upto middle in the former species, whereas, it reaches near antrum in *C. melissa*. The species appears to be moderately common in its type-locality.

Etymology: The specific name, *Clepsis neomelissa* sp. nov. is derived from the name of a species i.e. *C. melissa* Meyrick, to which it forms a sibling complex.

Dicellitis **Meyrick**

Dicellitis Meyrick, 1908 *J. Bombay Nat. Hist. Soc.*, **18**: 616.
Type-species: *Dicellitis nigritula* Meyrick, 1908, *ibidem*, **18**: 616, by monotypy.

Dicellitis nigritula **Meyrick**

Dicellitis nigritula Meyrick, 1908, *J. Bombay Nat. Hist. Soc.*, **18**: 616. - 1912, *in* Wagner, *Lepid. Catal.*, **10**: 53. - 1913, *in* Wytsman, *General Insect.*, **149**: 52, pl. 4, fig. 59. - Diakonoff, 1939, *Zool. Med.*, **21**: 213, figs. 11R-S, 16B-C. - Clarke,

1955, *Cat. type-spec. Microlepid. BMNH described by Edward Meyrick*, **1**: 217.
- 1958, *Cat. type-spec. Microlepid. BMNH described by Edward Meyrick*, **3**: 96,
pl. 48, figs. I-Id.

Male genitalia (Plate-9, Figs. A-B): Uncus very long, sharply curved at right angle,
neck slightly narrower, apex flat; socii absent; tegumen moderately broad, hood-like;
gnathos arms thin, joined distally, tip pointed; transtilla band-like, curved, moderately
broad, slightly broader at middle; vinculum thin, U-shaped; valva long, broad, roughly
rectangular in outline, broader at base, costa straight, sacculus well sclerotized, rest of
the valva relatively less sclerotized, uniform throughout, cucullus slightly narrow than
base of valva, inner surface finely hairy; aedeagus moderately long, gradually curved
at almost right angle, tip pointed, vesica without cornuti.

Female genitalia (Plate-9, Fig. C): Papillae anales flat, broad, foot-shaped; anterior
apophyses longer than posterior apophyses; sterigma connected to anterior apophyses;
ostium bursae wide; antrum rounded, broader than ductus bursae; ductus bursae thin
and long, membranous throughout; corpus bursae globular in shape, signum single,
patch-like, roughly rectangular in outline.

Alar expanse: 13–14 mm.

Material examined:

Himachal Pradesh: Dist. Solan; UHF, Nauni, 1360 m, 10-11, ix.1998, 50 ♂♂, 33♀♀.
        12.ix.1999, 1♂ 2♀♀; Dharampur, 1500 m, 16.vii.1999, 1♂. Dist. Kangra:
        SRH, Kangra, 800 m, 12.vi.1999, 2♀♀; KV, Palampur, 700 m, 24.vi.1999, 1♂;
        Andhretta, 900 m, 26–27.ix.1999, 2♂♂.
Punjab: Dist. Roopnagar; YH, Roopnagar, 350 m, 21.x.1999, 1♂, 1♀.

Distribution: India (North Coorg), Sri Lanka (Diakonoff, 1976).

Larval host plant: Unknown

Remarks: In the absence of any type designation, Clarke (1958) selected a lectotype
of the type-species, *Dicelletis nigritula* Meyrick of this monotypic genus (i.e. *Dicel-
letis* Meyrick), proposed by Meyrick (1908). Diakonoff (1939) has furnished an out-
line of the male and the female genitalia of the type-species without any description.
Diakonoff (1976) reported this species for the first time from Nepal (Kathmandu) and
again figured its genitalia.

It may be pointd out that the genus *Dicelletis* Meyrick is conspicuous due to the
stalking of the veins R_3, R_4 and R_5 of the forewing. Besides this, it has been observed
that there is a unique patch-like signum in the female genitalia which is a significant
character in the diagnosis of the aforesid genus. Such a modification has not been seen
in any of the species, presently studied or the species otherwise discussed (Freeman,
1958; Razowski, 1977; Diakonoff, 1976, 1982). It is, therefore, legitimately inferred
that this genus is an exception in the tribe Archipini having a non-dagger shaped
signum.

Having known from South India (North Coorg), the species, under reference, is recorded from North West India for the first time. Also to plug the gap, an illustrated account of the male and the female genitalia is adequately given here. The species is very common in this area and has been captured between an altitude range of 350 m (Roopnagar) to 1500 m (Dharampur). However, it is rather more abundant in one of the localities i.e., Nauni (Solan, HP) in the North Western Himalaya.

Ulodemis Meyrick

Ulodemis Meyrick, 1907, *J. Bombay Nat. Hist. Soc.*, **17**: 736.
Type-species: *Ulodemis trigrapha* Meyrick, 1907, *ibidem*, **17**: 736, by monotypy.

Ulodemis trigrapha Meyrick

Ulodemis trigrapha Meyrick, 1907, *J. Bombay Nat. Hist. Soc.*, **17**: 736. Fernald, 1908, *Genera Tortricidae*: 49, 63. Meyrick, 1912, *in* Wagner, *Lepid. Catal.*, **10**: 23. 1913, *in* Wytsman, *General Insect.*, **149**: 26. Meyrick, 1930, *in* De Joannis, *Ann. Soc. Ent. France*, **98**: 713. Fletcher, 1929, *Mem. Dep. Agric. India* (Ent.), **11**: 233. Diakonoff, 1939, *Rec. Indian Mus.*, **41**: 176, 179. Clarke, 1955, *Cat. type-spec. Microlepid. BMNH described by Edward Meyrick*, **1**: 316. - 1958, *Cat. type-spec. Microlepid. BMNH described by Edward Meyrick*, **3**: 260, pl. 30 figs. I-Ia. Simon Thomas, 1962, *Bull. Econ. Affairs Agr.*, **1**: 36, 89.

Male genitalia (Plate-9, Figs. D-G): Uncus long, strongly clavate, gradually curved, broad apically, hood-shaped; socii ill-defined; gnathos arms long, broad, joined before middle to tip, dentate dorsally beyond middle, proximal two dents small, medial six dorso-distally directed, extreme distal one straight; tegumen broad; vinculum thin, U-shaped; juxta shield-like; valva broad, slightly sclerotized, rather membranous, costa differentiable by an oblique slightly more sclerotized hairy border, sacculus well sclerotized, narrow, gradually arched, extending up to middle, central plicate disc not differentiable, cucullus rounded, continuous with costa and sacculus; aedeagus moderately long, pistol-shaped, anterior one-fourth bent at right angle, bent portion wide, vesica with two thin long needle-like cornuti; caulis small, ribbon-like.

Female genitalia (Plate-9, Fig. H): Papillae anales flat, foot-shaped; anterior apophyses longer than posterior apophyses; sterigma bilobate, both lobes anteriorly directed, posterior marging straight, connected with anterior apophyses; ostium bursae small; antrum reduced, slightly wider than ductus bursae; ductus bursae moderately long, straight, membranous throughout, cestum reaching slightly beyond middle, corpus bursae ovoid, signum dagger-shaped, slender.

Alar expanse: Male, 20–22 mm, Female, 21–23 mm.

Material examined:
Himachal Pradesh: Dist. Solan; UHF, Nauni, 10.ix.1998, 2♂♂, 2♀♀, 13–14.ix.1999, 3♂♂, 1♀.

Uttaranchal: Dist. Dehradun: FRI, 700 m, 22.iv.1999, 1♂, 24.ix.1999, 1♂,25.ix.1999, 1♀.

Distribution: Bhutan, Nepal (Diakonoff, 1976).

Larval host plant: *Vibrurnum* sp. (Fletcher, 1921).

Remarks: The genus *Ulodemis* Meyrick is represented by only two species i.e., *U. trigrapha* and *U. falsa*, the former reported from Bhotan (now spelled as Bhutan) and the latter from India (Nilgiri Hills, South India) by Meyrick (1907) and Meyrick (1914) respectively. Diakonoff (1976) has reported the former species from Kathmandu (Nepal) and the latter from Sri Lanka. The type-species i.e., *U. trigrapha* Meyrick of the genus is being reported from India. The identification of the species has been personally confirmed after its comparison with the lectotype slide (Male, Bhotan, 5.92, slide no. JFGC-6853) in the NHM, London.

Neocalyptis Diakonoff

Neocalyptis Diakonoff, 1941, *Teubia*, **18**: 407.
Type-species: *Neocalyptis telutanda* Diakonoff, 1941, *ibidem*, **18**: 407, text-fig. 2, pl. 18, fig. 6, by original designation.

Remarks: The genus *Neocalyptis* has been proposed on the basis of a new species i.e., *N. telutanda* as is type-specis from Java by Diakonoff (1948). On the basis of this diagnosis, two species i.e., *affinisana* (Walker) and *conicus* sp. nov. have been identified as belonging to this genus (i.e., *Neocalyptis* Diakonoff) during the course of present investigations. Like other morphological characters, both the species have been found to be truly congeneric on their male genitalic characters, as well. The uncus is long, broad and slightly clavate and both the arms of the gnathos are fused apically. The transtilla is produced into large broad and dorsally directed dentate lobes (labis after Diakonoff). The valva is small, broad and semi-oval in shape. The congeneric nature of the species could not be ascertained on the basis of their female genitalia, as the smae is wanting in the latter species.

Key to the species of the genus *Neocalyptis* Diakonoff

Male genitalia with uncus broad, hardly clavate,
straight, labides with apex rounded, aedeagus more
or less pistol-shaped............................ ***affinisana* Walker**
-Male genitalia with uncus long, slender, clavate,
rounded, labides with apex produced into a small
triangle ventrally, aedeagus simple, straight, conical   ***conicus* sp. nov.**

Neocalyptis affinisana (walker)

Tortrix affinisana Walker, 1863, *List Specimens Lepid. Insects Colln. Br. Mus.*, **28**:

328. Walsingham, 1887, *in* Moore, *Lepid. Ceylon*, **3**: 493. Cotes and Swinhoe, 1889, *Cat. Moths of India*: 696, no. 4746.

Capua affiniana; Meyrick, 1912, *in* Wagner, *Lepid. Catal.*, **10**: 10. - 1913, *in* Wytsman, *Genera Insect.*, **149**: 15. - 1914, *Suppl. Ent.* **3**: 47. - 1930, *in* De Joannis, *Am. Soc. Ent. France*, **98**: 709. - 1934: 29.

Epagoge affiniana; Diakonoff, 1941, *Treubia*, **18**: 213. - 1941, *Treubia* **18**: 411. - 1947, *Tijdschr. Ent.*, **88**: 342. - 1948, *Bull. Mus. Hist. Nat.*, **20**: 342.

Epagoge affinisana; Diakonoff, 1952, *Verh. Naturf. Ges. Basel*, **63**: 144. Obraztsov, 1955, *Tijdschr. Ent.* **98**: 224.

Neocalyptis affinisana; Diakonoff, 1976, *Zool. Verh. Leiden*, **144**: 99. - 1982, *Zool. Verh. Leiden*, **193**: 91.

Male genitalia (Plate-10, Figs. A-B)

Uncus long, moderately broad, somewhat clavate, top flat, finely setosed apically on inner side; socii absent; tuba analis not traceable; tegumen broad; gnathos arms thin, slightly arched, joined at tip, tip pointed; vinculum thin, U-shaped, transtilla modified as labis, dorsal margin denate, both lobes of labis separate; juxta shield-shaped, small; valva small, broad, costa membranous, gradually arched, sacculus sclerotized, broader at base, narrowing distally, central plicate disc narrow, aedeagus moderately long, slightly bent, posteriorly pointed, vesica without cornuti; caulis small.

Female genitalia (Plate-10, Fig. C)

Papillae anales flat, broad; anterior apophyses longer than posterior apophyses, sterigma joined to anterior apophyses, ostium bursae broad; antrum reduced; ductus bursae long and narrow; corpus bursae globular in shape, simple, signum absent.

Alar expanse

14–15 mm.

Material examined

Uttaranchal: Dist. Dehradun; FRI 700 m, 22–26.iv.1999, 3♂♂, 1♀, 22–25.ix.1999, 13♂♂, 4♀♀, 17–19.iv.2000, 25♂♂, 4♀♀.

Distribution

India, Nepal, Sri Lanka, HongKong, Malaysia, Sumatra, Java, Brunei, Sabah, Sulawesi (Robinson *et al.*, 1994).

Larval host plant

Polyphagous (Diakonoff, 1982).

Remarks

According to Robinson *et al.* (1994), *Neocalyptis affinisana* (Walker) is apparently one of the most common species out of thirteen species otherwise known under this genus from South East Asia. It seems appropriate to record here that while reporting this species from Nepal, Diakonoff (1976) shifted it from the genus *Epagoge* Hübner to form a new combination under the genus *Neocalyptis* Diakonoff. Cotes and Swinhoe (1889) have earlier listed this species from Ceylon (=Sri Lanka). Accordingly to Robinson *et al.*(*loc. cit.*), the altitude range of this species varies from lowland to 1800 m and the present sample comprising fifty individuals (forty-one males, nine females) has been captured from an elevation of 700 m (Dehradun: Uttaranchal). It has been observed that all the individuals of the species, under reference, are quite consistent in having a broad, blackish brown fascia in apical region of the forewing, which is somewhat interrupted. In spite of the fact that the species is quite common, as per present surveys, the same is, however, not listed in the catalogue pertaining to the National Reference collection record at FRI, Dehradun (Roonwall *et al.*, 1964). Recording of this species from the above mentioned localities represent an additional record of this species from India as the same has earlier been reported from Andaman Islands (Robinson *et al.*, 1994)).

Neocalyptis conicus sp. nov.

Male

Alar expanse: 12 mm. Vertex ochreous greyish; frons ochreous white; labial palpus ochreous brown, moderate in size, third segment minute, slightly dropping; antenna filiform, yellowish brown bearing black specks; forewing with costa moderately arched, apex more or less rounded, termen slightly oblique, tornus obtuse, anal margin straight, uniformly covered with fulvous scales, with irregular and ill-defined black patches, median fascia oblique, triangular, black, preapical spot in the form of an irregular and ill defined black triangle, costa with four ill-defined strigulae, anal margin with irregular and ill-defined black patches, fringes with double row of cilia, inner row brownish yellow with black apices, outer row brownish yellow throughout, tornal cilia long and black; hindwing quadrate, greyish brown, fringes with double row of cilia, the latter uniformly coloured, relatively longer towards anal margin; prothoracic and mesothoracic legs greyish black, with yellow rings, metathoracic legs light greyish brown.

Wing venation (Plate-11, Figs. B-C)

Forewing with Sc ending slightly before middle of costa, R_1 arising slightly before middle of cell, ending slightly beyond middle of costa, R_2 nearer R_3 than R_1, R_2, R_3 and R_4 at almost equal distance, R_4 and R_5 stalked, arising slightly before upper angle of cell, R_4 ending at costa, R_5 ending at termen, M_1 arising from upper angle of cell, M_1 and M_2 almost parallel, M_3 bent strongly towards M_2 at base, CuA_1 arising well before lower angle of cell, CuA_2 arising almost in the middle of cell, CuP visible

only distally, 1A+2A forked at base; hindwing with $Sc+R_1$ ending at posterior one-fifth of costa, R_5 and M_1 short stalked, Rs to costa, M_1 to termen, M_2 bent towards M_3 at base; M_3 and CuA_1 connate, arising from lower angle of cell, CuA_2 originating slightly beyond middle of cell, CuP vestigial, visible only in distal half, 1A+2A forked at base, 3A present, slightly diverging terminally.

Male genitalia (Plate-11, Figs. D-E)

Uncus long, clavate, broader at base, rounded apically, narrow, long, socii ill-defined; tuba analis well developed, moderately sclerotized; gnathos arms weak, attached to tuba analis, arms joined apically to form a pointed tip; tegumen rather narrow; vinculum thin, U-shaped; transtilla produced into large, broad and dorsally directed labis, the latter dentate dorsally, both lobes slightly joined medially, easily separable; valva small, broad, roughly rounded, costa atrophied, membranous, gradually arched, central plicate disc wide, sacculus well sclerotized, ending in a very small free protuberance, reaching well beyond middle, cucullus not differentiated; aedeagus straight, somewhat conical, moderately long, posteriorly pointed, vesica without cornuti.
Female genitalia: Not examined.

Material examined

Holotype: Uttaranchal: Dist. Dehradun; FRI, 700 m, 24.ix.1999, ♂.

Larval Host Plant

Unknown

Remarks

A lone specimen representing an unnamed species conforms to the characterization of the genus *Neocalyptis* Diakonoff and could not be specifically identified from the NHM, London, besides the relevant literature (Diakonoff, 1948, 1976, 1982; Robinson *et al.*, 1994). Accordingly, it is being named as *Neocalyptis conicus* sp. nov. The species is closely allied to *N. affinisana* (Walker) from which it differs in some genitalic details as given in the key.

Etymology

The specific name is derived due to the conical shape of the aedeagus in the male genitalia of this species.

Meridemis Diakonoff

Diakonoff , 1976, *Zool. Verh. Leiden*, **144**: 100.
Type-species: *Meridemis furtiva* Diakonoff, 1976, *ibidem*, **144**: 102, figs. 86–87, by original designation.

Remarks: While proposing the genus *Meridemis* on the basis of a new species i.e., *M. furtiva* from Nepal, Diakonoff (1976) has mentioned that in terms of male genitalic structures, it goes nearer to the genus *Homona* Walker and due to small size and facies on the forewing it resembles *Epagoge* Hübner. In addition to this, the author has also furnished keys for separation of the males of four species i.e. *M. furtiva* Diakonoff, *M. detractana* (Walker), *M. invalidana* (Walker) and *M. bathymorpha* Diakonoff and females of the latter three species. The structure of the transtilla and the uncus in the male genitalia and the colliculum and cestum in the female genitalia has been utilized for framing the keys. Further, while making the following general remark, "that the genus comprises so closely allied species, of probably a recent origin" the author has suggested a thorough reinvestigation of the genitalia of the available material of all the species, particularly those of *M. invalidana* and *M. detractana*.

During the course of present studies, a phenon comprising ninety-four individuals (sixty-eight males, twenty-six females) was compared with the reference collections at FRI, Dehradun and IARI, New Delhi and the entire sample was initially identified as *Epagoge invalidana* (Walker). However, it was subsequently found to contain three more sibling species. Not only that the male genitalia of the presently examined four species are broadly congeneric but also conform to the type-species i.e., *Meridemis furtiva* Diakonoff of the genus *Meridemis* Diakonoff. Further, the critical scrutiny of the presently collected material shows that three out of four species also form a natural group as evident from their female genitalia. The female of the species *M. punjabensis* sp. nov. could not be collected and hence not examined. Whereas, two species i.e., *M. invalidana* (Walker) and *M. bathymorpha* Diakonoff have been identified from the published literature (Meyrick, 1908; Fletcher, 1921; Obraztsov, 1954; Diakonoff, 1976, 1982) but the other two could not be identified from any source, including National and International Museums. Accordingly, these species have been named as *Meridemis obraztsovi* and *Meridemis punjabensis* as new to science. While making interspecific discrimination of the presently dealt with species, it has further been investigated that structure of the aedeagus can least be employed for framing a key. In the present studies, besides other morphological traits, the male and the female genitalic structures have been utilized to prepare a single consolidated key from which either species/sex can be identified.

Further, the reinvestigation of the wing venation shows that the vein 6 (M_1) and 7 (Rs) in the hindwing are stalked in all the presently studied species. Though, Diakonoff (1976) has shown these veins stalked in the figure of the type-species of the genus, under reference (fig. 83), but while giving the diagnosis of the genus, has erroneously mentioned that these veins are connate in the hindwing.

Key to the species of the genus *Meridemis* Diakonoff

1. Male genitalia with aedeagus slightly curved;
    transtilla simple, ribbon-like, sides hardly narrower
    than in middle; female genitalia with cestum as long
    as ductus bursae, reaching near antrum ....   *invalidana* **Walker**

-Male genitalia with aedeagus more or less straight, transtilla narrower at sides, middle dilated; female genitalia with cestum never as long as ductus bursae   2

2. Male genitalia with uncus slender, hardly clavate, transtilla strongly biconvex in middle . . . . *punjabensis* **sp. nov.**
   -Male genitalia with uncus broader, clavate, transtilla convex only in one direction   3

3. Male genitalia with transtilla strongly convex in middle ventrally, female genitalia with antrum rounded, cestum extending beyond middle of ductus bursae, reaching about three-fourth of total length . . . . *bathymorpha* **Diakonoff**
   -Male genitalia with transtilla strongly convex in middle from dorsal side; female genitalia with antrum funnel-shaped, cestum not extending beyond middle of ductus bursae . . . . *obraztsovi* **sp. nov.**

Meridemis invalidana (Walker)

Tortrix invalidana Walker, 1863, *List Specimens Lepid. Insects Colln. Br. Mus.*, **28**: 327. Walsingham, 1887, *in* Moore, *Lepid. Ceylon* **3**: 493 (Ceylon). Cotes and Swinhoe, 1889, *Catal. Moths of India*: 696, no. 4750.

Epagoge invalidana; Meyrick, 1908, *J. Bombay Nat. Hist. Soc.*, **18**: 617. Diakonoff, 1941, *Treubia*, **18**: 410. - 1947, *Tijdschr. Ent.*, **88**: 341. - 1948, *Bull. Mus. Hist. Nat.*, **20**: 343.

Capua invalidana; Meyrick, 1912, *in* Wagner, *Lepid. Catal.*, **10**: 9. - 1913, *in* Wytsman, *Genera Insect.*, **149**: 14. - 1934, *in* Caradja and Meyrick, *Iris*, **49**: 29. Fletcher, 1917, *Proc. Second Ent. Meet.*: 300. - 1921, *Mem. Dep. Agric. India* (Ent.), **6**: 34.

Dichelia retractana (nec Walker) Walsingham, 1885, *in* Swinhoe, *Proc. Zool. Soc. London*, **1885**: 881. - 1887, *in* Moore, *Lepid. Ceylon*, **3**: 192, pl. 208 fig. II. Cotes and Swinhoe, 1889, *Cat. Moths India*: 697. Meyrick, 1934, *in* Caradja and Meyrick, *Iris*, **49**: 29.

Epagoge retractana (nec Walker) Walsingham, 1900, *Ann. Mag. Nat. Hist.*, **7** (5): 483. Diakonoff, 1939, *Zool. Med.* **21**: 165. - 1941. *Treubia*, **18**: 379.

Capua retractana (nec Walker) Meyrick, 1912, *in* Wagner, *Lepid. Catal.*, **10**: 9. - 1913, *in* Wytsman, *Genera Insect.*, **149**: 14.

Homona retractana (nec Walker) Obraztsov, 1954, *Tijdschr. Ent.*, **97**: 176, 180, figs. 56-58, 67-69. - 1955, *ibidem*, **98**: 208. - 1957, *ibidem*, **100**: 312.

Male genitalia (Plate-12, Figs. A-B): Uncus broad, clavate, neck broad; socii absent; gnathos arms slender, weak, joined distally, apex pointed; tegumen broad, flat, slightly arched; transtilla ribbon-like, sides hardly narrower than in middle, upper edge slightly concave, juxta plate-like, rounded dorsally; vinculum weak, U-shaped; valva small, broad, somewhat oval in shape, distally pointed, costa atrophied, membranous,

Plate 9

Plate 10

Plate 11

Plate 12
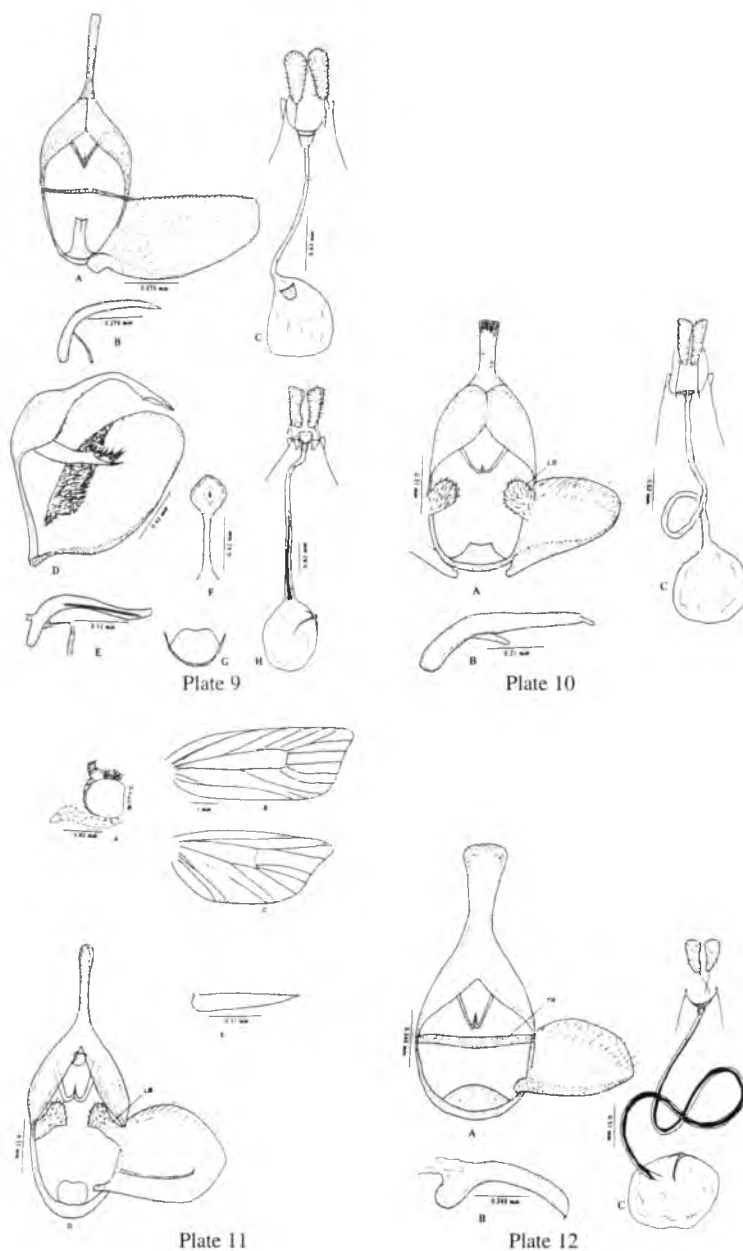
PLATES 9–12. Figs. 9A–C: *Dicelletis nigritula* Meyrick: A. Male genitalia: Ventral view. B. Aedeagus, C. Female genitalia: Ventral view, Figs. D–H: *Ulodemis trigrapha* Meyrick: D. Male genitalia: Lateral view, E. Aedeagus, F. Uncus, G. Juxta, H. Female genitalia: Ventral view. Figs.10A–C: *Neocalyptis affinisana* (Walker): A. Male genitalia: Ventral view, B. Aedeagus, C. Female genitalia: Ventral view.
Figs.11A–C: *Neocalyptis conicus* sp. nov.: A.Labial palpus, B. Forewing venation, C. Hindwing venation, D. Male genitalia: Ventral view, E. Aedeagus. Figs.12A–C: *Meridemis invalidana* (Walker): A. Male genitalia: Ventral view, B. Aedeagus, C. Female genitalia: Ventral view.

strongly arched; sacculus well sclerotized, as long as valva, central plicate disc uniformly broad throughout; cucullus reduced, undifferentiable; aedeagus curved; lower tip pointed, ending in a small terminal tooth, vesica without cornuti.

Female genitalia (Plate-12, Fig. C): Papillae anales flat, foot-shaped; anterior apophyses longer than posterior apophyses; sterigma joined to anterior apophyses; ostium bursae narrow; antrum narrow; ductus bursae very long, coiled; cestum well developed, as long as ductus bursae, reaching near antrum, corpus bursae rounded, small, dagger-shaped, signum present.

Alar expanse: Male, 13–14 mm, Female, 16–17 mm.

Material examined

Uttaranchal: Dist. Dehradun, FRI, 700 m, 22–26.iv.1999, 22♂♂, 8♀♀.
Himachal Pradesh: Dist. Kangra; SRH, Kangra, 800 m, 12.vi.1998, 6♂♂, 2♀♀.

Distribution: India, Sri Lanka (Diakonoff, 1982).

Larval host plant: Unknown.

Remarks: As evident from the remarks of the genus *Meridemis* Diakonoff, the sample representing *M. invalidana* (Walker) is quite confusing to sort out into same or different species. This perhaps goes in accordance with Diakonoff (1976), who states, "there existed a considerable confusion about the identity of this species", the author adds that "though Bradley and Obraztsov made an attempt to sort out this anomaly by examination of the genitalia partly of types and partly of other old and authenticated material in the British Museum (Natural History), London, the untimely death of latter author prevented the publication of his results". In order to fill this void, Diakonoff (1976) after reexamination of the material has proposed the fresh synonymy besides reporting the species, under reference, as a new combination under *Meridemis* as *Meridemis invalidana* (Walker). This arrangement is also followed in the present studies. It may also be mentioned that the species has earlier been enlisted as *Epagoge invalidana* by Meyrick (1908), *Capua invalidana* by Fletcher (1921) and *Dichelia retractana* (nec Walker) Walsingham by Swinhoe (1885) and Cotes and Swinhoe (1889). The collection of the present material from the above mentioned localities is an additional record of this species from India. The species appears to be quite abundant in this part of the country.

Meridemis punjabensis sp. nov.

Male: Alar expanse: 13–14 mm. Vertex and frons pale ochreous; antenna filiform, labial palpus small, 1–2 times diameter of eye, porrect, relatively darker than vertex and frons, second segment covered with scales on upper and lower sides, third segment minute, thorax pale ochreous, with slight tinge of grey; forewing with costa moderately arched to middle then almost straight, apex rounded; termen straight, tornus obtuse, anal margin straight, costal fold very small, ground colour pale, costa with two black

semi-oval spots, one immediately after costal fold and terminating before centre, small, somewhat rounded represents median fascia, second somewhat expanded and less rounded, representing subapical spot, anal margin darker brown, fringes pale ochreous, with blackish apices, tornal cilia slightly longer, pale throughout; hindwing quadrate, apex somewhat produced, brownish, fringes having double row of cilia, latter pale and brown; legs light brown, tibia with ill-defined black rings, hind tibia normal.

Female: Alar expanse: 16–17 mm. Forewing with costa strongly arched at base, somewhat concave beyond middle, apex rounded, somewhat produced, termen slightly concave, costal spots diffused to form more or less continuous line at costa with slight expansion at origin of spot, remaining same as in male.

Wing venation (Plate-13, Figs. B–C): Forewing with Sc ending at middle of costa, R_1 arising before middle of discal cell; R_1, R_2 and R_3 at equal distance apart, R_4 and R_5 stalked, stalk extending before middle, R_4 to costa, R_5 to termen, M_2 nearer M_3 than M_1, M_3 coming closer to M_2 at base, CuA_1 arising before lower angle of cell, curved and parallel to M_3; CuA_2 arising almost in the middle of cell, CuP vestigial, visible only distally, $1A+2A$ forked at base; hindwing with $Sc+R_1$ ending at posterior one seventh of costa, R_s and M_1 stalked, Rs to apex, M_1 to termen, M_2 bent and coming closer to M_3 at base; M_3 at base; M_3 and CuA_1 connate, at lower angle of cell, CuA_2 arising beyond middle of cell; CuP visible only distally; $1A+2A$ forked basally, 3A present, straight, gently diverging outwardly.

Male genitalia (Plate-13, Figs. D-E): Uncus slender, slightly clavate apically; socii absent; gnathos thin and weak, arms joined distally, apex pointed; tegumen broad, flat, slightly arched; transtilla band-like, strongly biconvex in middle, narrower towards both ends; juxta plate-like, rounded dorsally; vinculum weak, U-shaped; valva small, broad, distal margin somewhat pointed, costa atrophied, membranous, strongly arched; sacculus well sclerotized, as long as valva, central plicate disc broad, narrowing towards distal margin; cucullus reduced, undifferented; aedeagus straight, lower lip with a small terminal tooth, vesica without cornuti.

Female genitalia: Not examined.

Material examined

Holotype: Dist. Roopnagar; YH, Roopnagar, 350 m, 21.x.1999,♂.
Paratypes: Dist. Roopnagar, YH, Roopnagar, 350 m, 21.x.1999, 2♂♂.

Larval host plant Unknown

Remarks: *Meridemis punjabensis* sp. nov. is yet another species sorted out from *M. invalidana* complex. Unlike other species, it is conspicuous in having reduced and hardly clavate uncus in the male genitalia. The transtilla too is strongly expanded and biconvex in the middle and different from other species of the genus. Unlike all other species, *M. punjabensis* sp. nov. appears to be quite rare. This is the only species of this genus collected from the Siwaliks in the State of Punjab.

Etymology: The name is proposed as *Meridemis punjabensis* sp. nov. derived after the name of the State (Punjab) of the locality from where the species has been collected.

Meridemis bathymorpha Diakonoff

Meridemis bathymorpha Diakonoff, 1976, *Zool. Verh. Leiden*, **144**: 104.

Male genitalia (Plate-14, Figs. A–B): Uncus broad, clavate; socii absent; gnathos arms thin and weak, joined distally, apex pointed; tegumen broad and flat, slightly arched; transtilla band-like, narrower from both ends, strongly convex towards ventral side in middle; vinculum weak, U-shaped; juxta plate-like, dorsally rounded; valva small, moderately broad, costa atrophied, membranous, gradually arched; sacculus well sclerotized, as long as valva, central plicate disc moderately broad, narrowing towards apex; cucullus reduced, undifferented; aedeagus moderately long, gradually curved, lower lip pointed, ending in a small terminal tooth, vesica with two needle-like cornuti.

Female genitalia (Plate-14, Fig. C): Papillae anales flat, broad; anterior apophyses longer than posterior apophyses; sterigma reduced, joined to anterior apophyses; ostium bursae moderately broad, antrum broad, rounded, cup-shaped; ductus bursae very long, coiled; cestum broad, well developed, extending upto three-fourth towards termen, corpus bursae rounded, signum dagger-shaped, a small sclerotized patch present near signum.

Alar expanse: Male, 13–15 mm, Female, 16–18 mm.

Material examined:
Himachal Pradesh: Dist. Solan; UHF, Nauni, 1360 m, 12–13.ix.1999, 24♂♂, 10♀♀.

Distribution: Nepal (Diakonoff, 1976).

Larval host plant: Unknown.

Remarks:
The present species has been identified as *Meridemis bathymorpha* Diakonoff after its critical comparison with the description and diagrams given by Diakonoff (1976), who reported it as a new species from Nepal (Kathmandu). The species is being reported for the first time from India. The species is moderately common and collected from Nauni (1360 m) in the Western Himalaya. However, after going through the material examined by Diakonoff (1976), the altitude range of this species varies from 200 to 1800 m in Nepal.

Meridemis obraztsovi sp. nov.

Male: Alar expanse: 13–15 mm. Vertex and frons light pale ochreous, antenna filiform; labial palpus small, 1.2 times diameter of eye, porrect, relatively darker than vertex and frons, second segment covered with scales on upper and lower sides, third segment minute, thorax pale ochreous, with slight tinge of grey; forewing

with costa moderately arched to middle then almost straight, apex rounded; termen straight, tornus obtuse, anal margin straight, costal fold very small, ground colour pale, costa with two black semi-oval spots, one immediately after costal fold and terminating before centre, small, somewhat rounded represents median fascia, second somewhat expanded and less rounded, representing subapical spot, anal margin darker brown, fringes pale ochreous, with blackish apices, tornal cilia slightly longer, pale throughout; hindwing quadrate, apex somewhat produced, brownish, fringes having double row of cilia, latter pale and brown; legs light brown, tibia with poorly defined black rings, hind tibia normal.

Female: Alar expanse: 16–18 mm. Forewing with costa moderately arched at base, somewhat concave beyond middle, apex rounded, somewhat produced, termen slightly concave, costal spots diffused, more or less continuous upto costa, with slight expansion at origin of spots. The rest as in male.

Wing venation (Plate-15, Figs. B-C): Forewing with Sc ending at middle of costa, R_1 arising before middle of discal cell; R_1, R_2 and R_3 at equal distance apart, R_4 and R_5 stalked, stalk extending before middle, R_4 to costa, R_s to termen, M_2 nearer M_3 than M_1, M_3 coming closer to M_2 at base, CuA_1 arising before lower angle of cell, curved and parallel to M_3; CuA_2 arising almost in the middle of cell, CuP vestigial, visible only distally, $1A+2A$ forked at base; hindwing with $Sc+R_1$ ending at posterior one seventh of costa, R_s and M_1 stalked, R_s to apex, M_1 to termen, M_2 bent and coming closer to M_3 at base; M_3 and CuA_1 connate, at lower angle of cell, CuA_2 arising beyond middle of cell; CuP visible only at tip; $1A+2A$ forked at base; 3A present, straight, gently diverging outwardly.

Male genitalia (Plate-15, Figs. D-E): Uncus broad, clavate; socii absent; gnathos arms thin, weak, jointed distally, apex pointed; tegumen broad, flat, slightly arched; transtilla band-like, strongly convex in middle from dorsal side; vinculum weak, U-shaped; juxta plate-like; valva small, broad, semi-oval in shape, distal margin more or less rounded, costa atrophied, membranous, gradually arched; sacculus well sclerotized, as long as valva, central plicate disc uniformly broad throughout; cucullus reduced, undifferentiated; aedeagus almost straight, lower lip with a small terminal tooth, vesica with two needle-like cornuti.

Female genitalia (Plate-15, Fig. F): Papillae anales flat, broad; anterior apophyses longer than posterior apophyses; sterigma reduced, joined to anterior apophyses; ostium bursae wide; antrum well-developed, funnel-shaped; ductus bursae very long, coiled; cestum extending upto middle of total length of ductus bursae, corpus bursae rounded, with a small dagger-shaped signum.

Material examined:
Holotype: Himachal Pradesh: Dist. Sirmour, Renuka Lake, 740 m, 5-8.viii.1998, ♂.
Paratypes: Himachal Pradesh: Dist. Sirmour, Renuka Lake, 740 m, 5-8.viii.1998, 12♂♂, 6♀♀.

Larval host plant: Unknown.

Remarks: As mentioned under the remarks of the genus *Meridemis* Diakonoff, the present species has been sorted out from *invalidana* complex after examining the external genitalia of a series of eight male and five female specimens. The new species i.e., *Meridemis obraztsovi* is allied to *M. invalidana* (Walker) and *M. bathymorpha* Diakonoff, but can be distinguished from them on the basis of certain characters of the male and the female genitalia as per key, given above.

Etymology: The species is named as *Meridemis obraztsovi* sp. nov. and is dedicated to a Tortricid worker N. S. Obraztsov, who along with Bradley made an intensive investigation to sort out the *invalidana* species complex but could not publish its results due to his untimely death.

Homona walker

Walker, 1863, *List Specimens lepid. Insects Colln. Br. Mus.*, **28**: 424.
Godana Walker, 1866, *List Specimens lepid. Insects Colln. Br. Mus.*, **35**: 1800. Type-species: *Godana simulana* Walker, 1866 (= *Pandemis mentiana* Walker, 1833) by subsequent designation by Walsingham, 1913, Biologia cent. - am., *Zool., Lepid. - Heterocera*, **4**: 207.
Ericia Walker, 1866, *List Specimens lepid. Insects Colln. Br. Mus.*, **35**: 1802. Type-species: *Ericia aestivana* Walker 1866, *ibidem*, by subsequent designation by Meyrick, 1913, *in* Wytsman, *Genera Insect.*, **149**: 19.
Ericiana Strand, 1910, *Societas Ent.*, **25**: 34. Type-species: *Ericia aestivana* Walker, 1866, *List Specimens lepid. Insects Colln. Br. Mus.*, 35: 1803, by subsequent designation (for *Ericia* Walker) by Meyrick, 1913, *in* Wytsman, *Genera Insect.*, **149**: 19.
Type-species: *Homona fasciculana* Walker, 1863 (=*Tortrix coffearia* Nietner) *ibidem*, **28**: 424.

Homona coffearia (Nietner)

Tortrix coffearia Nietner, 1861, *Observations on the enemies of Coffee Tree in Ceylon*: **24**. - 1872. *The Coffee Tree and its enemies*: 16. - 1880 *ibidem* (new Edn): 116. Guérin, 1864. *Rev. Magaz. Zool.*, **1864**: 64. Walingham, 1887, *in* Moore, *Lepid. Ceylon*, **3**: 494. Cotes and Swinhoe, 1889, *Catal. Moths of India*: 696, no. 4747.
Homona coffearia, Meyrick, 1912, *in* Wagner *Lepid. Catal.*, **10**: 15. - 1913, *in* Wytsman, *Genera Insect.* **149**: 19, pl. 2, fig. 30. - 1932, *Exot. Microlepid*, **4**: 253. Fletcher, 1914, *South Ind. Insects*: 452. fig. 330. - 1917, *Proc. Second Ent. Meet.*: 20, 28. - 1919, *Second Hundred Notes Ind. Insects*: 143. - 1921, *Mem. Dep. Agric. India* (Ent.), **6**: 35. - 1932, *Imp. Counc. Agr. Res. Mon.*, **2**: 14. Du Pasquier, 1932, *Principales maladies paras, théier, a caféier on Extr. - Or:* 406 B, fig. Diakonoff, 1939, *Rec. Indian Mus.*, **41**: 321. - 1947, *Tijdschr. Ent.*, **88**: 342. - 1948, *Bull. Mus. Hist. Nat.*, **20**: 344. - 1948, *Treubia*, **19**: 504, 506, figs. 22, 27. - 1952, *Verh. Naturf. Ges. Basel*, **63**: 208. Matsumura, 1931, *Illus.* 6000

Ins. Japan: 1067, Esaki, 1932, *Icon. Ins. Jap.*: 1450. Inoue, 1954, *Check List Lepid. Japan*: 87. Kawabe, 1964, *Kenkyu to Hyoron, biann. Rep. Hosei School*, **11**: 17 seq. Issiki, 1957, *in Icon., Het. Jap. Col. Nat.* **21** (1): 77, pl. 13, figs. 389–390. Okano, 1959, *in Icon. Het. Jap. Col. Nat.* 265, pl. 177, figs. 5a, 6. Simon Thomas, 1962, *Bull. Econ. Affairs Agr.*, **1**: 33, 89. Diakonoff, 1976, *Zool. Verh. Leiden*, **144**: 78.

Homona fasciculana Walker, 1863, *List Specimens lepid. Insects Colln. Br. Mus.*, **28**: 424.

Pandemis menciana Walker, 1863, *List Specimens lepid. Insects Colln. Br. Mus.*, **28**: 310. Cotes, 1896, *Account insects and mites attack Tea plant in India*: 3, no. 4. Meyrick, 1912, *in* Wagner *Lepid. Catal.*, **10**: 15. - 1913, *in* Wytsman, *Genera Insect.*, **149**: 19. - 1932, *Exot. Microlepid.*, **4**: 253.

Godona simulana Walker, 1866, *List Specimens lepid. Insects Colln. Br. Mus.*, **35**: 1801.

Cacoecia simulana; Warren, 1888, *Proc. Zool. Soc. London.* **1888**: 337. Cotes and Swinhoe, 1889, *Catal. Moths of India*: 695, no. 4741.

Capua fasciculana ;Walsingham, 1900, *Ann. Mag. Nat. Hist.*, **7** (5): 575.

Capua menciana; Walsingham, 1900, *Ann. Mag. Nat. Hist.*, **7** (6): 482.

Homona menciana; Meyrick, 1910, *Trans. Ent. Soc. Lond.*, **1910**: 432. - 1912, *in* Wagner *Lepid. Catal.*, **10**: 15. - 1913, *in* Wytsman, *Genera Insect.*, **149**: 19. Fletcher, 1921, *Mem. Dep. Agric. India* (Ent.), **6**: 37. - 1932: 14.

Homona coffearia menciana; Meyrick, 1934, *in* Caradja and Meyrick, *Iris.*, **48**: 29.

Homona coffearia forma *menciana*; Meyrick, 1935, *in* Caradja and Meyrick, *Iris*, **49**: 49. - 1937, *in* Caradja and Meyrick, *Iris.*, **51**: 173.

Male genitalia (Plate-16, Figs. A-C): Uncus broad, clavate, apically finely setosed on inner side, neck somewhat broad; socii absent; gnathos arms thin, gently curved, joined distally, tip pointed; tuba analis traceable, slightly sclerotized; tegumen broad, flat, slightly arched; vinculum thin, broad, U-shaped, saccus absent; transtilla band-like, broad, narrowed and concave from both sides in middle; juxta plate-like, triangular; valva broad, costa membranous, weakly sclerotized, gradually arched, cucullus not differentiable, sacculus well sclerotized, proximally distinguished by a membranous plicate disc, ending in double dent-like free termination, aedeagus long, more or less pistol-shaped, bent at one-fourth in anterior portion, bend conspicuous beyond ductus ejaculatorius, wall of aedeagus with one large and numerous small carinae on its left lateral side slightly beyond middle, coecum moderate, vesica with two long cornuti; caulis extending upto middle of aedeagus, Z-shaped.

Female genitalia (Plate-16, Fig. D): Papillae anales large, flat; anterior apophyses longer than posterior apophyses; ostium bursae broad, surrounded by cup-shaped sterigma, the latter connected to anterior apophyses; antrum broad, inverted bell shaped; ductus bursae long, wide, curved around corpus bursae, anterior three-fourth portion sclerotized, remaining membranous, cestum nearly as long as sclerotized

portion, coiled; corpus bursae small, rounded, signum dagger-shaped; ductus seminalis arising near antrum.

Alar expanse: Male, 20–22 mm, Female, 25–28 mm.

Material examined:

Uttaranchal: Dist. Dehradun, FRI, 700 m, 21-26.iv.1999, 17♂♂, 18♀♀, 18-19.iv.2000, 29♂♂, 9♀♀; Vikasnagar, 600 m, 26.ix.1999, 1♂.
Himachal Pradesh: Dist. Sirmour, Renuka Lake, 740 m, 08.viii.1998, 2♂♂, 13.iv.1999, 1♂, Dist. Solan, UHF, Nauni, 1360 m, 13.ix.1999, 1♂.

Distribution: India, Sri Lanka, China, Thailand, W. Malaysia, Java, Brunei, Sabah, Sarawak (Robinson *et al.*, 1994).

Larval host plant: Tea, Coffee, *Lantana camara* (Fletcher, 1921).

Remarks: As evident from the distribution mentioned above, through *Homona coffearia* Nietner is a common species, yet it poses a difficulty in its identification. During the course of present studies, the female individuals of this species were compared with a lone female specimen in the reference collection housed at FRI, Dehradun. While separating genus *Homona* Walker from *Archips* Hübner, Diakonoff (1982) has mentioned that the veins R_4 and R_5 of the forewing in the former genus are mostly stalked but fail once in a while. Further, the author has stated that both the aforesaid genera can decisively be separated on the basis of structure of the saccular region (strongly sclerotized throughout its whole width) of the valva in the male genitalia. In addition to this, the presence of long and coiled ductus bursae in the female genitalia of the genus *Homona* has also been underlined as a diagnostic character by the author (Diakonoff, *loc. cit.*). In view of this, fifty-one male and twenty-seven female individuals, examined presently, have been identified as *Homona coffearia* Nietner. It may be mentioned that species, under reference, is highly sexually dimorphic in view of its size, shape and pattern of the forewings. The conspecificity of the male and female individuals has been established on the basis of similar wing venation in either case.

In an earlier publication, Diakonoff (1948) while making a distinction between *H. coffearia* Neitner and *H. wetan* Diakonoff (the latter occurring throughout Java) has mentioned that the latter cannot be a subspecies of *coffearia* as has been established on the basis of the female genitalia, particularly the structure of the ostium bursae and the colliculum, otherwise the females of both the species superficially resemble each other as far as the wing shape, colouring and wing pattern are concerned. While doing so, the author has figured the make genitalia of five species i.e., *H. wetan* Diakonoff, *H. intermedia* sp. nov. *H. nubifera* (Walker), *H. scutina* sp. nov., and *H. difficilis* (Meyrick) alongwith the species, under reference.

In a later publication, Diakonoff (1976) while separating *H. nakaoi* Yasuda from *coffearia* has mentioned that the former species does not descend below 1400 m altitude, while the latter seldom ascend 750 m though the author has examined only

two specimens of *H. coffearia* (one from 1400 m and the other from 2200 m) in a total of twenty-four individuals otherwise studied. The species, under reference, is redescribed from seventy-eight individuals (fifty-one males, twenty-seven females), out of which seventy-three (forty-seven males, all females) have been collected from a single locality *viz.*, FRI, Dehradun (700 m), one from Vikasnagar (600 m), three from Renuka lake (740 m) and only one from UHF, Nauni (1360 m). On the basis of present survey, the species appears to be quite common in Dehradun in the month of April.

Scotiophyes Diakonoff

Diakonoff, 1976, *Zool. Verh. Leiden*, **144**: 74.
Type-species: *Adoxophyes faeculosa* Meyrick, 1928, *Exot. Microlepid.*, **3**: 453, by
    original designation.

Scotiophyes faeculosa (Meyrick)

Adoxophyes faeculosa Meyrick, 1928, *Exot. Microlepid.*, **3**: 453, Clarke, 1955, *Cat.*
    type-spec. Microlepid. BMNH described by Edward Meyrick, **1**: 139. - 1958,
    Cat. type-spec. Microlepid. BMNH described by Edward Meyrick, **3**: 20, pl. 10
    figs. 3-3a.

Male genitalia (Plate-16, Fig. E):
Uncus long and slender, gradually curved, base dilated and gradually narrowing, tip round pointed; socii ill-defined, gnathos arms long, slender, joined beyond middle, apices free, rounded; tegumen hood-like; vinculum thin, U-shaped; valva fleshy, membranous, hairy, plicate disc hairy, costa membranous, hairy, sacculus well sclerotized, sinuate, convex in the middle, cucullus broad, rounded, densely hairy; aedeagus short, broad, walls heavily sclerotized, vesica without cornuti.

Female genitalia: Not examined.

Alar expanse: Male, 21 mm.

Material examined:
Himachal Pradesh: Dist. Solan; UHF, Nauni, 1360 m, 10.ix.1998, 1♂.

Distribution: India (Ramgarh, UP), Nepal, North Thailand (Robinson *et al.*, 1994).

Larval host plant: Unknown.

Remarks: Following Meyrick (1928), the species, under reference, was tentatively identified as *Adoxophyes faeculosa* Meyrick from its description and its identification was further confirmed by comparison of its male genitalia with lectotype (U.P. Ramgarh, 17.6.25, slide no. JFGC-6799) of the species, given by (Clarke, 1958). While working on the Tortricoidea of Nepal, Diakonoff (1976) has mentioned that because of the shape of the forewing, absence of the costal fold, entirely different facies and the male genitalia of the species is remarkably different and do not conform to the type-species *viz.*, *Adoxophyes heteroidana* Meyrick of the genus
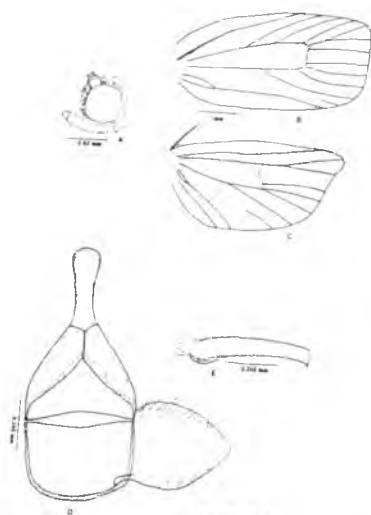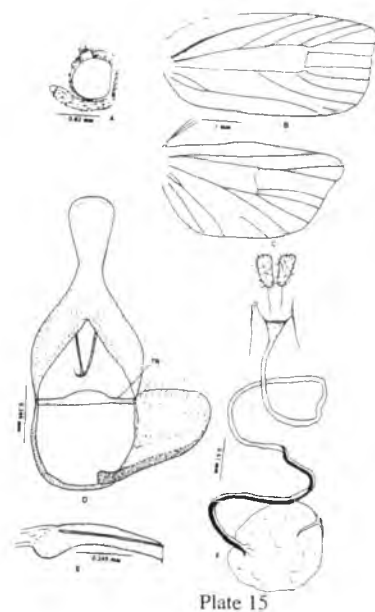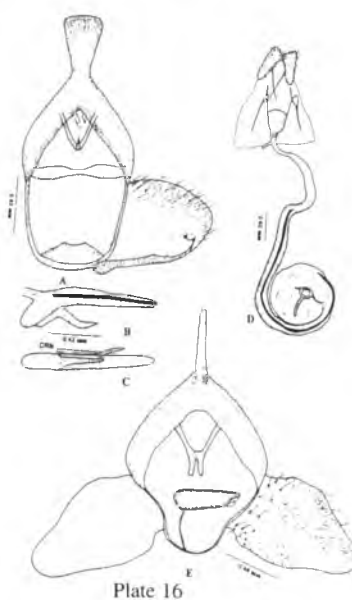
Plate 13
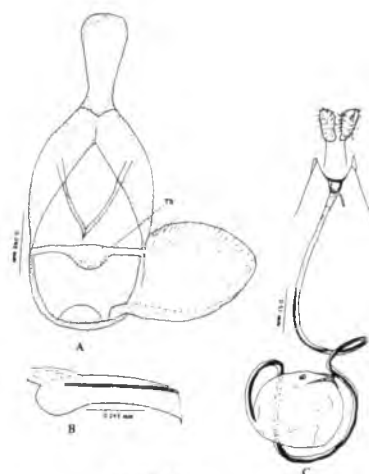
Plate 14

Plate 15

Plate 16

PLATES 13–16. Figs. 13A–E: *Meridemis punjabensis* sp. nov.: A. Labial palpus, B. Forewing venation, C. Hindwing venation, D. Male genitalia: Ventral view, E. Aedeagus. Figs. 14A–C: *Meridemis bathymorpha* Diakonoff: A. Male genitalia: Ventral view, B. Aedeagus, C. Female genitalia: Ventral view. Figs. 15A–F: *Meridemis obraztsovi* sp. nov.: A. Labial palpus, B. Forewing venation, C. Hindwing venation, D. Male genitalia: Ventral view, E. Aedeagus, F. Female genitalia: Ventral view.

Figs. 16A–D: *Homona coffearia* (Nietner): A. Male genitalia: Ventral view, B. Aedeagus, C. Aedeagus: ventral view, D. Female genitalia: Ventral view. Fig. E: *Scotiophyes faeculosa* (Meyrick): Male genitalia: Ventral view.

Adoxophyes Meyrick. Owing to these differences, Diakonoff (*loc. cit.*) proposed a new genus *Scotiophyes* with *Adoxophyes faeculosa* Meyrick as its type-species. The new combinaion proposed as *Scotiophyes faeculosa* (Meyrick) by Diakonoff (*loc. cit.*) is followed in the present studies.

The species has earlier been reported from Ramgarh (U.P.) (Meyrick 1928) and its collection from FRI, Dehradun (Uttaranchal) is an additional collection site in the North West India. Somehow or the other, the female of the species could neither be collected by Meyrick (1928) and Diakonoff (1976) nor during the course of present surveys.

CONCLUSION

According to Horak and Brown (1991), the subfamily Tortricinae can be divided into eleven tribes i.e., Archipini, Phricanthini, Tortricini, Schoenotenini, Cochylini, Cnephasiini, Epitymbiini, Sparganothini, Atteriini, Eulini and Ceracini. During the course of present studies, the material referable to the former tribe viz., Archipini could only be collected from North-West part of India. The tribe is conspicuous as the adults fold their wings in such a way that they appear bell-shaped in outline, when at rest. The examination of the male genitalia of various species i.e., *Archips machlopis* (Meyrick), *A. mertias* sp. nov., *A. pseudotermias* sp. nov., *A. termias* (Meyrick), *A. kangraensis* sp. nov., *A. carteri* sp. nov., *Clepsis tricensa* (Meyrick), *C. melissa* (Meyrick), *C. neomelissa* sp. no., *Dicelletis nigritula* Meyrick, *Ulodemis trigrapha* Meyrick, *Neocalyptis affinisana* (Walker), *Neocalyptis conicus* sp. nov., *Meridemis invalidana* (Walker), *M. punjabensis* sp. nov., *M. bathymorpha* Diakonoff, *M. obraztsovi* sp. nov., *Homona coffearia* (Nietner) and *Scotiophyes faeculosa* (Meyrick) reveals that the tribe is also conspicuous due to the presence of an uncus, which is beset with a very fine brush of hair below its apex in the male genitalia. Similarly, the valva is always with costa atrophied and membranous, the sacculus being strongly sclerotized and separated by a membranous central plicate disc. In this regard, all the nine genera i.e., *Mochlopyga* Diakonoff, *Archips* Hübner, *Clepsis* Guenée, *Dicelletis* Meyrick, *Ulodemis* Meyrick, *Neocalyptis* Diakonoff, *Meridemis* Diakonoff, *Homona* Walker and *Scotiophyes* Diakonoff studied here are allied to one another in this tribe. With regard to the female genitalia, the tribe is diagnosed by the presence of a dagger-shaped signum in the corpus bursae. However, two exceptional cases have been noted where the signum is either non-dagger shaped as in the genus *Dicelletis* Meyrick or is totally wanting as in *Neocalyptis* Diakonoff. Further, it has also been observed that the male genitalia in this tribe are uniform to such an extent that some of the closely allied genera such as *Homona* Walker and *Archips* Hübner and *Neocalyptis* Diakonoff and *Clepsis* Diakonoff are difficult to separate only on the basis of male genitalic characters. In fact, their separation is facilitated through an inclusion of characters of the wing venation as well as secondary sexual characters like coremata or abdominal pits. For example, the genus *Archips* Hübner can only be separated from its allied genus i.e. *Homona* Walker on the basis of the abdominal pits which are present on second and third abdominal tergites in the former genus and wanting in the

latter. Besides, the veins R_4 and R_5 in the forewing are free in *Archips* and stalked in *Homona*. It will not be out of place to quote here that in view of the genitalia, the species *Tortrix tricensa* Meyrick has been described in the genus *Neocalyptis* Diakonoff by Diakonoff (1976), whereas, on the basis of the veins R_4 and R_5 of the forewing being free, this has been referred under the genus *Neocalyptis* Diakonoff being stalked, the correct placement of this species lies in the latter genus. Amongst the nine genera, mentioned above, except the genus *Meridemis* Diakonoff, the shape and size of the aedeagus has profitably been used for an interspecific discrimination of the species referable to the genera *Archips, Neocalyptis* and *Clepsis*. The species of the genus *Meridemis* can best be segregated on the shape of the transtilla and that of the uncus rather than the aedeagus.

In view of the above, it is strongly felt that in order to make the present inference more meaningful, the collection and examination of Archipini fauna from other regions be also examined. Further, it may also be added that the Archipin moths are economically quite important as the larvae of various species (500 worldwide, (Obraztsov, 1954; Powell, 1964) are associated with various vegetations and feed in rolled leaves (Horak and Brown, 1991)). Keeping this in view, it is also emphasized that though the host plants of various species, presently examined, have been recorded from the relevant literature, yet it is felt that the life history studies be undertaken on priority basis in India.

Abbreviations

CRN: Carinae, FRH: Forest Rest House, FRI: Forest Research Institute, KV: Krishi Vishawvidyalya, LB: Labis, NHM: Natural History Museum, PU: Panjab University, PUP: Punjabi University, Patiala, TR: Transtilla, UHF: University of Horticulture and Forestry, YH: Youth Hostel.

ACKNOWLEDGEMENTS

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Innervation of hair sensilla present on the ovipositor of the silkmoth, *Bombyx mori*. L

D. Manjulakumari* and Geetha Bali

*Department of Microbiology, Jnanabharathi, Bangalore University,
Bangalore 560056, India*

ABSTRACT: A large number of hair sensilla on the ovipositor which influence oviposition behaviour in silkmoth *Bombyx mori* are innervated each by a single neuron, a feature characteristic of mechanoreceptors while some of the hairs on the ovipositor are also innervated by a single neuron but they have a blunt tip, a characteristic feature of the chemoreceptors. © 2004 Association for Advancement of Entomology

KEYWORDS: *Bombyx mori*, hair sensilla, innervation, mechanoreceptor, chemoreceptor

Generally insects are equipped with a variety of sensory structures which are highly specialized. These sensory structures influence several behaviours pertaining to feeding, mating, selection of oviposition site and environmental factors. The sensory structures present on the ovipositor are known to play a role in egg laying behaviour in several insects (Barton Browne, 1960; Fox, 1966; Myers, 1969; Norris, 1970; Brown and Anderson, 1998). In the silkmoth *Bombyx mori* the egg count falls down with the ablation of hair sensilla present on the ovipositor and the moth lays fewer eggs on the substratum with rough surface (Manjulakumari and Geethabali, 1991). Geethabali and Manjulakumari (1987) have shown the presence of four types of hairs on the ovipositor of the silkmoth. They vary in their length measuring between 203 to 667 μm.

In the present investigation Zawarzin's intra vital staining technique (Plotnikova and Nevmyvaka, 1980) was adapted with some modifications to reveal the nature of these hairs. About 0.5 ml of 1% methylene blue prepared in silkworm saline (Yamaoka, 1977) was injected into the freshly emerged moths. After one hour the ovipositor was dissected out and fixed in 8% ammonium molybdate for 24 hours at 4 °C. The material was washed thoroughly in distilled water and dehydrated in ethanol repeatedly thrice, cleared in xylene and mounted.

Irrespective of the type, each hair is innervated by a single neuron and the cell body measuring between 7.7 to 20 μm occurs just below the hair shaft (Fig. 1) with the dendrite terminating at the base of hair sensilla (Fig. 2). The axons from these
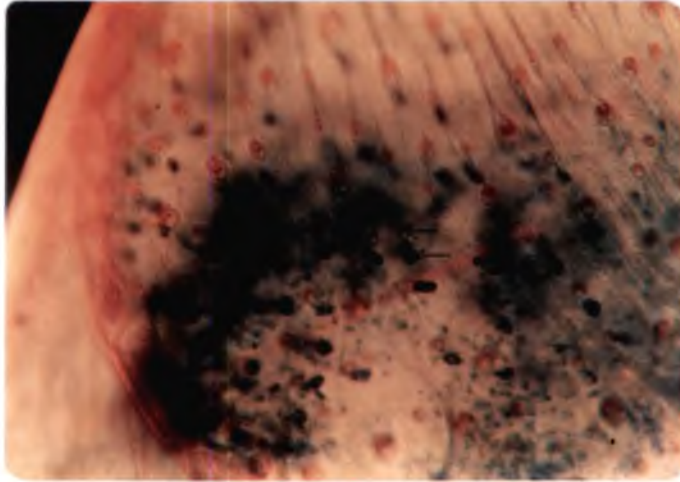
*Corresponding author

FIGURE 1. Photomicrograph showing the neurons (in blue) at the base of each hair (in brown) (100 X magnification)
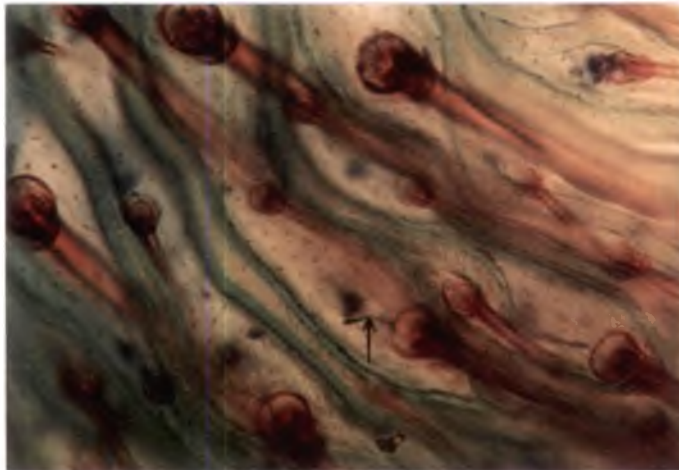

FIGURE 2. Dendrite of a neuron ending at the base of hair (arrow showing the dendrite) (100 X magnification).

sensilla form one bundle on each anal papilla (Fig. 3) and two such bundles of axons enter the last abdominal ganglion. Similar observations have also been made in the dragonfly *Brachythemis contaminata* F. wherein a single bipolar neuron has been shown to innervate trichoid sensilla on the mouth parts with the axons joining together forming a sensory nerve (Wazalwar and Tembhare, 2000). In insects the number of neurons associated with hair sensilla ranges from a single neuron to 50 or more
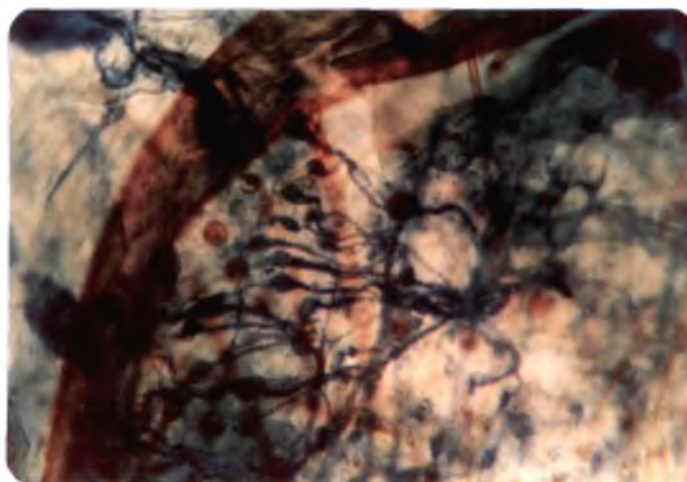
FIGURE 3. Axons from each neuron joining to form a bundle in the anal papilla (100 X magnification).

(Slifer *et al.*, 1959; Slifer and Sekhon, 1964). Such multiple innervation is especially true in chemoreceptive sensilla. Generally, mechanoreceptive hairs are known to be innervated by a single bipolar neuron whose dendritic processes end at the margin of the hair socket (Wigglesworth, 1972). Earlier studies on the silkmoth showed that many hairs have pointed tips which is also a common feature of mechanoreceptive hairs (Geethabali and Manjulakumari, 1987). Further behavioural studies carried out in the laboratory confirmed that the sensory hairs on the ovipositor of the silkmoth play a critical role in providing mechanosensory input about the oviposition site (Manjulakumari and Geethabali, 1991). However, it was observed earlier that some of the hairs had blunt tips and could be backfilled with Silver stain (Geethabali and Manjulakumari, 1987), which is suggestive of chemoreceptive hairs (Wigglesworth, 1972). Wolbarsht and Dethier (1958) have reported such chemosensilla which are innervated by a single bipolar neuron in the blowfly and Kendall (1970) in the desert locust, *Schistocerca gregaria*. From the present study, the hair sensilla present on the ovipositor of the silkmoth *Bombyx mori* appear to be mechanosensory, with at least some of them being chemosensory.

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Evaluation of suitable technique and determination of appropriate stage for sampling thrips in rose flowers

P. Durai Murugan* and A. Jagadish

College of Agriculture Department of Agricultural Entomology, University of Agricultural Sciences, GKVK, Bangalore 560065, India

ABSTRACT: Chilli thrips, *Scirtothrips dorsalis* Hood has become a serious pest on rose flowers in India in recent times. It feeds all stages of rose flowers by remaining concealed between the petals. To determine a suitable and efficient sampling method and sampling stage of rose flowers, a laboratory experiment was conducted. Three sampling methods of extraction of thrips from rose flowers *viz.*, Liquid detergent method, Turpentine vapour method and Beating method were compared for four stages of rose flowers *viz.*, unopened buds, calyx opened young buds, harvestable flowers and fully opened flowers. Among the three methods compared for making percent efficiency estimates, the liquid detergent method (84.13, 85.47 and 85.04) followed by beating method (82.08, 80.68 and 80.94) recorded higher efficiency for the extraction of adults, larvae and total population of thrips respectively from rose flowers. The per cent efficiency of extraction of adults, larvae and total population of thrips present at the time of sampling was high on harvestable flowers (79.44, 79.32 and 79.21) and fully opened flowers (77.0, 75.73 and 75.78). The interaction effect between the method of extraction and the stages of flowers showed significant higher efficiency of extraction of thrips for beating and liquid detergent methods for harvestable and fully opened flowers. The present study revealed that the ideal flower stage for sampling of thrips is the harvestable flowers. With reference to the method of extraction, liquid detergent method and beating method are on par. However, in view of the easy and quicker results from the beating method, it can be recommended as the ideal method for enumerating the thrips inside rose flowers.
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Scirtothrips dorsalis Hood is one of the major pest of chillies and grapes in India. Recently, it has become a serious pest of rose flowers (Onkarappa and Mallik, 1998). Feeding by both nymphs and adults causes severe malformation of flowers and it reduces the market value of flowers. Normally, the quick method of estimating the population of thrips infesting a plant part is through gently beating the part on to a

*Corresponding author. Present address: Department of Agricultural Entomology, TNAU, Coimbatore 641003.

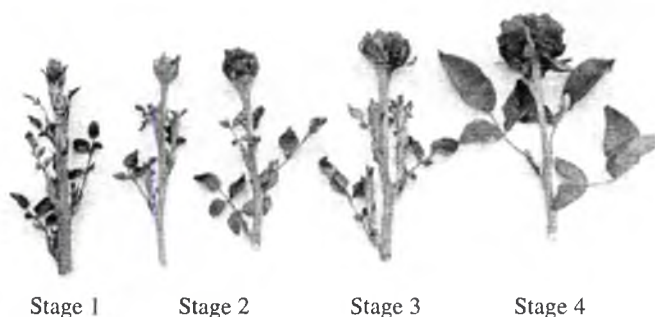Stage 1   Stage 2   Stage 3   Stage 4

PLATE 1. All the stages of rose flowers showing infestations by *Scirtothrips dorsalis* Hood.

contrastingly coloured paper board and counting them. These counts are made for two purposes, mainly for the determination of the effect of control measures. Counts are taken periodically for the purpose of monitoring the seasonal population fluctuations. However, since *S. dorsalis* damage rose flowers by remaining concealed between the petals, it was necessary to evaluate other methods also for population estimations. A laboratory experiment was therefore, made to determine the efficiency of three methods of extraction of thrips in rose flowers described by Taylor and Smith (1955), Lewis (1960) and Bagle (1993) were therefore compared.

The Local Red rose flowers were grouped into four stages *viz.*, unopened buds, calyx opened young buds, harvestable flowers and fully opened flowers. Ten flowers from each stage were picked at random from field and used to estimate the efficiency of the following three extraction methods (Plate 1).

Extraction with a detergent method was essentially that described by Taylor and Smith (1955). By this method, each sample of flowers was transferred into separate polythene bags. A few drops of alcohol were added and the bags were immediately tied with an elastic band. In the laboratory, these flowers were torn apart and placed in 0.1 per cent detergent solution (Triton X-700®) in a beaker and agitated to dislodge the thrips. Then the mixture was allowed to stand for ten minutes until most of the thrips settled to the bottom. After 10 minutes, the floral parts and other plant material were skimmed. Thrips were counted by placing the beaker over cross section paper. The unharvested thrips which were present along with the skimmed material were also counted, to estimate the total number of thrips.

Turpentine vapour method was similar to that of Lewis (1960). Turpentine vapour extractor (Lewis, 1960) (Fig. 1) was modified by using locally available material (Fig. 2) and used for the extraction of thrips. The apparatus consisted of a container with a lid at the top (A) and the bottom open and attached to a nylon net (B). In

2.5 cm

Cotton wool soaked in turpentine

Lamp glass

Perforated zinc gauze

wax seal

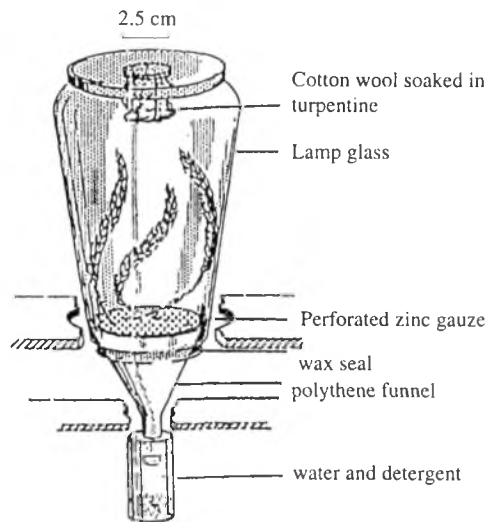polythene funnel

water and detergent

FIGURE 1. Turpentine vapour extractor (Lewis, 1970) for collecting Thysanoptera from Gramineae.

the centre of the lid from inside a cotton wool pad (C) was fixed. The container was snugly attached with a funnel whose bottom tip stood immersed in a beaker of detergent solution (D). This apparatus was held in position by a wooden stand. The cotton wool pad was made wet by a few drops of turpentine and flowers infested with thrips were placed in the container. Repelled by the turpentine vapour, thrips inside the flowers came out and fell into the detergent solution. After 1–2 hours, the thrips collected from the detergent solution were counted as in liquid detergent method. The unharvested thrips which were present on the flowers and in the apparatus were also counted to estimate the total number of thrips.

The beating method was similar to the method used by Bagle (1993). The infested rose flowers were beaten five times on to a contrasting black cardboard (since adults and larvae of *S. dorsalis* are yellowish) and were counted. The unharvested thrips which were present inside the petals after beating the flower were also counted, to estimate the total number of thrips. The efficiency of extraction methods was analysed statistically by adopting 3 × 4 factorial CRD.

The relative efficiency of thrips extraction for each stage of flowers for the three methods are presented in Table 1. Among the three methods compared for making efficiency ratings, the liquid detergent method (84.13, 85.47 and 85.04) followed by beating method (82.08, 80.68 and 80.94) recorded better efficiency for the extraction of adults, larvae and total population of thrips respectively from rose flowers. This is in conformity with the observation by (Henneberry *et al.*, 1964) and Ota (1968). Taylor and Smith (1955) reported the inefficient extraction of thrips by the turpentine vapour extraction method which is in agreement with the present results, showing

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TABLE 1. Relative efficiency of three methods of extracting thrips from rose flowers.

Stages of flowers (S)	Per cent efficiency of extraction methods (E)											
	Adult				Larva				Total population of thrips			
	TVM	LDM	BM	Mean	TVM	LDM	BM	Mean	TVM	LDM	BM	Mean
Unopened bud	47.67	83.83	73.50	68.33	52.63	86.66	72.23	70.51	52.63	82.53	72.10	70.09
Calyx opened young bud	53.67	80.00	75.84	69.84	49.11	83.80	73.74	68.89	50.27	83.09	74.93	69.43
Harvestable flower	61.67	87.67	88.99	79.44	59.15	89.02	89.81	79.32	59.29	89.04	89.31	79.21
Fully opened flower	56.00	85.00	90.00	77.00	57.84	82.42	86.93	75.73	57.40	82.51	87.42	75.78
Mean	54.75	84.13	82.08		54.68	85.47	80.68		54.90	85.04	80.94	
	F-test	S.Em±	CD (P = 0.05)		F-test	S.Em±	CD (P = 0.05)		F-test	S.Em±	CD (P = 0.05)	
Method of extraction (E)	*	1.77	5.02		*	0.92	2.61		*	0.54	1.53	
Flower stages (S)	*	2.04	5.80		*	1.06	3.01		*	0.62	1.76	
Interaction : E × S	NS	3.54			*	1.84	5.21		*	1.07	3.05	

* Significant; TVM —Turpentine vapour method; Harvestable thrips; NS—Non significant; LDM—Liquid detergent method Efficiency = × 100; BM—Beating method; Total thrips.
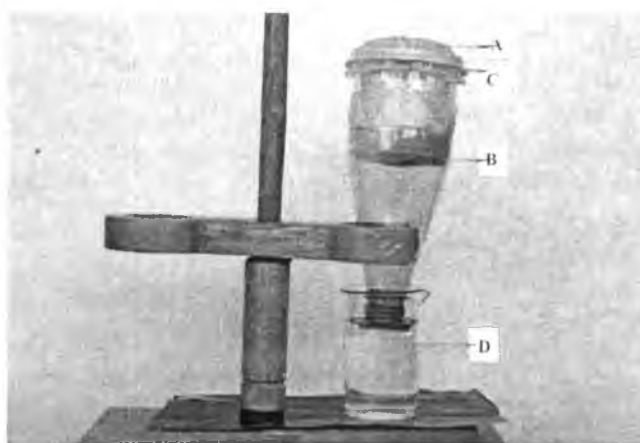
FIGURE 2. Modified Turpentine vapour extractor by using locally available material for extracting thrips from rose flowers.

lesser efficiency (54.75, 54.68 and 54.90) for the extraction of adults, larvae and total population of thrips, using turpentine vapours.

The efficiency of extraction of adults, larvae and total population of thrips was lower on unopened buds (68.33, 70.51 and 70.09) and calyx opened young buds (69.84, 68.89 and 69.43). The percentage efficiency of extraction of adults, larvae and total population of thrips present at the time of sampling was high on harvestable flowers (79.44, 79.32 and 79.21) and fully opened flowers (77.00. 75.73 and 75.78). This may be because of the loose arrangement of petals in these stages unlike the unopened buds and calyx opened buds, where the petals are tightly placed thereby inhibiting thrips movement.

The interaction effect between the method of extraction and the stages of flowers showed better efficiency of extraction of adults, larvae and total population of thrips for the beating method of extraction for harvestable flowers (88.99, 89.81 and 89.31) and it was on par with liquid detergent method of extraction for harvestable flowers (87.67, 89.02 and 89.04). In turpentine vapour method of extraction many thrips die and get stuck between the petals of the unopened and calyx opened young buds, leading to lower efficiency of extraction (Table 1).

From the above observations, the present study reveals that the ideal flower stage for higher thrips population count are the harvestable flowers. With reference to method of extraction liquid detergent method and beating method are on par. However, in view of the easy and quicker results from the beating method, this can be recommended as the ideal method for counting population of thrips inside rose flowers.

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The black aphid, *Toxoptera aurantii* (B. De F.) infests the orchid, *Oncidium* Gower Ramsay

V. S. Nagrare

National Research Centre for Orchids, Pakyong 737106, Sikkim, India

ABSTRACT: Black aphid *Toxoptera aurantii* (B. de F.) (Aphididae: Homoptera) infested inflorescence of *Oncidium* Gower Ramsay starting from January to mid-June under open polyhouse conditions. Its occurrence on *Oncidium* is reported for the first time from India. © 2004 Association for Advancement of Entomology

KEYWORDS: Black aphid, *Toxoptera aurantii*, *Oncidium*

Orchids of the genus *Oncidium* Gower Ramsay are small to very large epiphytic, lithophytic or terrestrial evergreen plants with nearly four hundred species native to the American tropics and subtropics (Bechtel *et al.*, 1992). *Oncidium* produces highly coloured attractive flowers and are adaptable to culture under wide range of climatic conditions. Potted plants and cut flowers are in high demand.

The black aphid, *Toxoptera aurantii* (B. de F.) (Aphididae: Homoptera) has been found to infest the spike starting from the bud stage and remained on the spike till the flowers withered. The aphid sucks the juice from rachis, buds as well as open flowers and excretes honeydew which supports the growth of black sooty mould that mars the beauty of the flower (Figs 1 and 2). Honeydew secretion also invites black ants. Both winged and wingless aphids were present. Aphid infestation on *Oncidium* has been seen starting from the cold months of January to moderately hot mid June, under open polyhouse conditions.

The black aphid, *T. aurantii* has been reported to occur worldwide on about 169 hosts, including citrus, tea, cocoa, papaw, macademia, feijoa, radish, black peper, pear, etc and the orchid, *Dendrobium chrysotoxum*, (Raychaudhuri, 1983; Chakrabarti and Sarkar, 2001). However, its occurrence on *Oncidium* is a new record from India. The aphids *Macrosiphum luteum* (Buckton) has been reported on orchids of the genera *Oncidium, Cattleya, Lycaste, Brassia, Epidendrum, Laelia* and *Castsetum* (Swezey, 1945) and *Cerataphis orchidearum* (Westwood) on various orchids, including *Vanilla* (Blackman and Eastop, 1984; Zimmerman, 1948; Klara *et al.*, 1997). As many as seven species of aphids are known from different orchids in India.

The biology of *T. aurantii* has been studied on citrus (Garg, 1980; Komazaki, 1993), tea (Das and Kakoty, 1992) and cocoa (Firempong, 1977). This aphid has

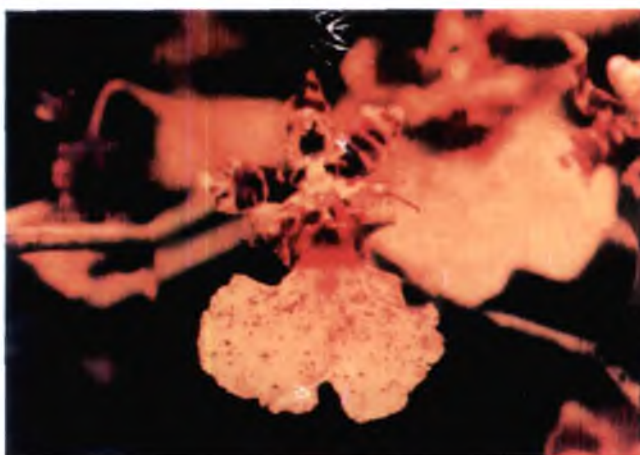FIGURE 1. *Toxoptera aurantii* infestation on rachis and bud of *Oncidium*.

FIGURE 2. *Oncidium* flower infested by *Toxoptera aurantii* showing black fungus.

been reported to transmit tristeza virus in citrus (Balaraman and Ramakrishnan, 1979; Dadmal *et al.*, 2000), yellow mosaic virus in tea (Ahlawat and Sardar, 1973) and papaya ring spot virus in papaya (Lana, 1980).

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Morphological variations in natural populations of *Anopheles (Cellia) pulcherrimus* Theobald collected from North-West India

Jagbir S. Kirti* and Jagdish Kaur

*Department of Zoology, Punjabi University, Patiala 147002, Punjab, India*

ABSTRACT: Eight types of morphological variations in wing and three in palpi, are recorded and illustrated from natural populations of *Anopheles (Cellia) pulcherrimus* Thoebald, collected from North-West India. © 2004 Association for Advancement of Entomology

The Indian Anophelines have been reported to show morphological variations from the type form. These variations in diffent species of *Anopheles* Meigen were earlier reported by several workers (Christophers, 1933; Ramakrishna, 1954; Subramanian and Nagendra, 1955; Bhatnagar *et al.*, 1958; Rajagopal and Chakraborty, 1960; Rahman *et al.*, 1960; Wattal *et al.*, 1960; Nagpal, 1990; Nagpal and Sharma, 1995). In *Anopheles (Cellia)* pulcherrimus Theobald, Nagpal and Sharma (1995) reported two kinds of palpal variations. We observed 11 types of wing or palpal variatons in *A. pulcherrimus* collected from different states of North-West India. This species is known to occur throughout India, Afghanistan, Turkey, Uzbekistan, Syria, South Kazakhistan (Knight and Stone, 1977). Though it is not a vector species in India, it has been reported to transmit malaria in northern Afghanistan and plains as well as valleys of Middle Asia according to Nagpal and Sharma (1995).

Extensive and intensive mosquito surveys were carried out in villages in the states of Punjab, Haryana, Himachal Pradesh and Uttaranchal. Adult mosquitoes were collected with the help of suction tube both from the cattle sheds and human dwellings during morning hours. The collected specimens were killed with ethyl acetate vapours, and pinned and preserved in air-tight insect cabinets. Identification was made using the keys of Christophers (1933); Puri (1954); Rao (1981) and Wattal and Kalra (1961). Diagrams were made of palpi and wings showing variations. The specimens have been preserved in the department as reference material.

Three variations were observed in palpi and eight in wings in the present studies. These variations were observed in the banding patterns, speckling and size of band. Nagpal and Sharma (1995) reported two types of variations in palpi. Details of

*Corresponding author
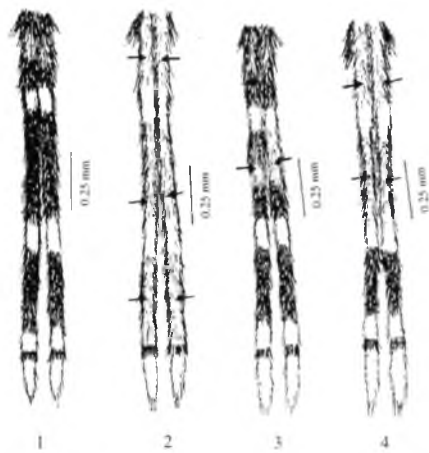
FIGURES 1–4. Variations in palpi of *Anopheles (Cellia) pulcherrimus*. Figure 1 represents the type form.
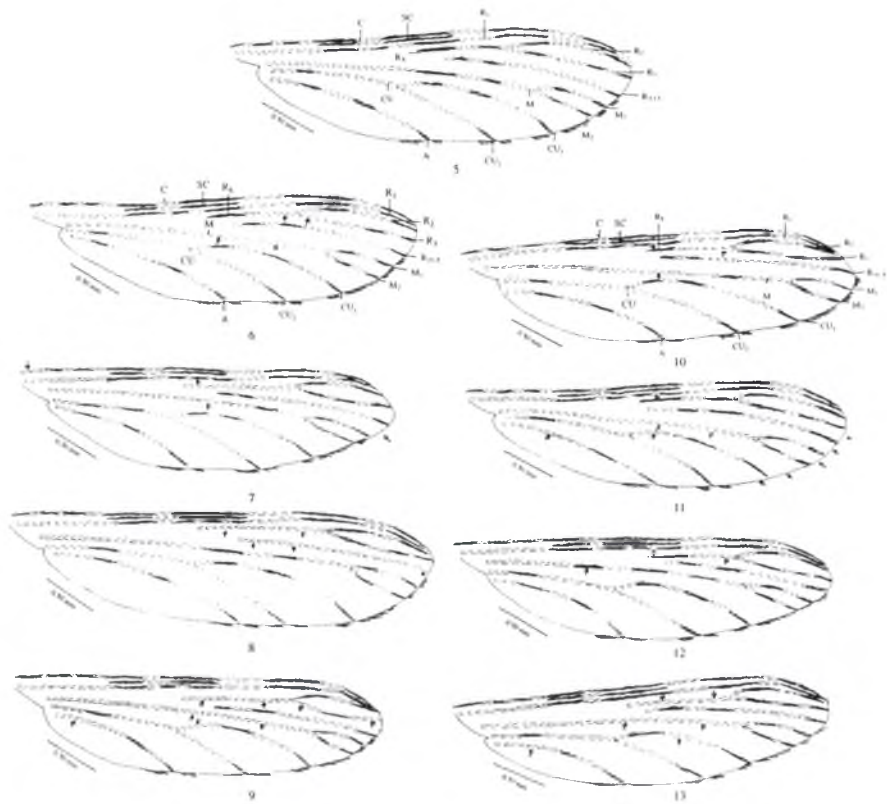
FIGURES 5–13. Variations in wings of *Anopheles (Cellia) pulcherrimus*. Figure 5 represents the type form.

Abbreviations

A	–	Anal Vein;	PHP	–	Prehumeral pale
AD	–	Apical dark;	PSD	–	Presector dark
C	–	Costa;	PSP	–	Presector pale
Cu	–	Cubitus;	R_1	–	Radius-one
Cu_1	–	Cubitus-one	R_2	–	Radius-two
Cu_2	–	Cubitus-two	R_3	–	Radius-three
HD	–	Humeral dark	R_{4+5}	–	Radius-four-plus-five
HP	–	Humeral pale	R_{4+5}–M	–	Radiomedial crossvein
M	–	Media	Rs	–	Radial sector
M_1	–	Media-one	Rs-R_{4+5}	–	Cross vein between radial sector
M_2	–	Media-two			and radius-four-plus-five
M–Cu	–	Media cubital cross vein	Sc	–	Subcosta
MD	–	Middle dark	ZSI	–	Zoological Survey of Inda

TABLE 1. Morphological variations in the palpi and wings of *Anopheles (cellia) pulcherrimus*.

Sl. No. of varaiation	Date of collection	Site of Collection	No. of specimens collected	Description of variation from the type form
Variations in Palpi				
1.	1.1X.1998	Raogarh, Kurukshetra	1	All the three dark areas pale, bearing dark scales on outer-sides (Fig. 2).
2.	13.VI1.1998	Mohie, Ludhiana	3	Middle dark band bearing pale scales at almost basal half on both palpi (Fig. 3).
3.	16.IV.1999	Asthal Bohr, Rohtak	3	Middle and basal dark area pale with dark scales on outsides (Fig. 4)
Variations in Wings				
4.	1.1X.1998	Raogarh, Kurukshetra	1	Vein R_s lacking a dark band near fork point; R_3 lacking basal dark spot; M totally pale both dark spots absent (Fig. 6).
5.	16. VI.1999	Asthal bohr, Rohtak	3	Prehumeral dark spot absent; R_1 with 3 dark spots below middle dark spot; both dark spots on R_s absent; one of dark spot at M absent; Cu with an additional dark spot; apical pale fringe larger including R_{4+5} (Fig. 7).
6.	16.IV.1999	Chandi, Rohtak	3	R_1 bearing 3 dark spots below middle dark inspite of 2; R_s and R_{4+5} totally pale (Fig. 8).

TABLE 1. *continued.*

Sl. No. of varaiation	Date of collection	Site of Collection	No. of specimens collected	Description of variation from the type form
7.	1.IX.1998	Reg. Eng. Coll., Kurukshetra	1	Dark spots at R_s and M absent; R_3 with a middle dark spot, Cu_1 and anal lacking basal dark spot (Fig. no. 9).
8.	13. VIII.1998	Mohie, Ludhiana	3	3 dark spots on R_1 below middle dark spot inspite of 2; dark spot near fork at R_s absent; M lacking one of dark spot (Fig. no. 10)
9.	13. VIII.1998	Mohie, Ludiana	3	R_1 bearing 3 dark spots below the middle dark spot; M totally pale; Cu_1 lacking one of dark spots; anal vein bearing 2 dark spots only; fringe spots between R_{4+5} and M_1, M_1 and M_2, M_2 and Cu_1, Cu_1 and Cu_2 absent (Fig. no. 11).
10.	16.IV.1999	Asthal Bohr, Rohtak	3	Middle dark spot at R_1 divided into 3; R_s lacking dark spot near fork; M bearing an additional dark spot (Fig. no. 12)
11.	1.VII.1998	Patiala	1	R_s totally pale; vein M lacking both dark spots; Cu_1 with 2 dark spots only; anal vein lacking one of the dark spots (Fig. no.13).

morphological variations, collection sites and the number of specimens collected from each village are given in Table 1 and Figs 1–3.

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New records of blow flies (Diptera: Calliphoridae) from India

Devinder Singh* and Inderpal Singh Sidhu

Department of Zoology, Punjabi University, Patiala 147002, Punjab, India

ABSTRACT: Four species of blow flies *Catapicephala ingens* (Walker), *Dexopollenia flava* (Aldrich), *Lucilia bazini* Seguy and *Isomyia tibialis* (Villeneuve) are recorded for the first time from India. Synonymy, material examined, distribution and remarks are provided for each species. © 2004 Association for Advancement of Entomology

KEYWORDS: Diptera, Calliphoridae, India

Because of their medical, veterinary and forensic importance, blow flies have remained attractive for taxonomists. So far, 364 species belonging to the family Calliphoridae are known from the Oriental Region, including 101 species from India. Senior-White *et al.* (1940) brought all the scattered works together in the form of 'Fauna of British India'. Twenty four more species have been added to the list after this monumental work by Peris (1951, 1952); Crosskey (1965); James (1970, 1977); Kurahashi (1970); Kurahashi and Tseunumaru (1976); Pajni and Gera (1983); Ghezta and Kumar (1991); Rognes (1993); Sidhu and Singh (2002)

Surveys were undertaken during the last four years for collection of blow flies from the North-western Indian States. Four species, *Catapicephala ingens* (Walker), *Dexopollenia flava* (Aldrich), *Lucilia bazini* Seguy and *Isomyia tibialis* (Villeneuve) were recorded for the first time from India.

Catapicephala ingens (Walker, 1860)

Musca ingens Walker, 1860 *J. Proc. Linn. Soc. Lond., Zool.*, **4**: 134.

Catapicephala ingens (Walker): Senior-White *et al.*, 1940. *Fauna Brit. India, Dipt.*, **6**: 104.

Material examined:

Himachal Pradesh: Shimla-2208M (1♀) 3.VIII.2000; Manikaran-1737M(2♀♀) 6.IX.2000; Kandi-2355M (4♂♂,11♀♀) 14.IX.2000; Chamba-996M (2♀♀) 21.IX.2000.

*Corresponding author

Uttaranchal: Parola-1452M(1♂,2♀♀) 29.V.2000; Mandal-1568M(1♀) 12.VI.2000. Coll. Inderpal Singh Sidhu.

Distribution:

India (Himachal Pradesh, Uttaranchal), Celebes.

Remarks:

This species was known so far only from Celebes. It resembles *C. splendens* Macquart but the two can be differentiated by the following combination of characters: presutural acrostichals 2 (3 in *splendens*), intra-alars 1 + 2 (1 + 3 in *splendens*), lateroscutellars 3 (2 in *splendens*), wings infuscated along anterior margin (hyaline in *splendens*) and palpi black (orange in *splendens*)

Dexopollenia flava (Aldrich, 1930)

Lispoparea flava (Aldrich, 1930). *Proc U.S. Nat. Mus.*, 78(1): 5. type loc., Mt Emei, Sichuan, China.

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Dexopollenia flava (Aldrich): Zumpt, 1956 *Flieg. Palae.* Reg., ; 65

Pollenia flava (Aldrich): James, 1977. *Cat. Dipt. Orient.* Reg. 3; 539.

Dexopollenia flava (Aldrich): Fan *et al.*, 1997 *Fauna Sin.*, 6: 431.

Material examined:

Uttaranchal: Munsayari-2290M (1♂, 2♀♀) 17.X.2001. Coll. Inderpal Singh Sidhu.

Distribution:

India (Uttaranchal), China and Japan.

Remarks:

This species was known from Japan and China so far. The specimens have completely yellow thorax. Senior-White *et al.* (1940) considered *Dexopollenia flava* a Palaearctic species though Kurahashi (1992, 1995) included it in the list of Oriental species.

Lucilia bazini Seguy, 1934

Lucilia bazini Seguy, 1934. *Encycl. Ent. (B) II Dipt.*, 7: 15, Fig. 13. type loc., Zi-Ka-Wei Shanghai, Kouling, Jiangzi, China.

Lucilia papuensis Park, 1962. *Kor. Journ. Zool.*, 5(2): 26.

Lucilia (Luciliella) bazini bazini Seguy: Fan, 1965. *Key Commmon Flies China*: 176 p.

Lucilia (Luciliella) bazini Seguy: Fan *et al.*, 1997. *Fauna Sin.*, 6: 203.

Material examined:

Haryana: Kalka-370M (1♂, 31♀♀) 3.X.1999. *Himachal Pradesh:* Jogindernagar-1500M (1♂,7♀♀) 16.IX.2000. *Uttaranchal:* Chickelghat-1850M (3♂♂,3♀♀)7.VI.20000; Dehradun-640M (1♀)3.X.2001. Coll. Inderpal Singh Sidhu.

Distribution:

India (Haryana, Himachal Pradesh, Uttaranchal), Malaysia, China and Japan.

Remarks:

Kurashashi (1998) reported this Palaearctic species for the first time from Malaysia in the Oriental Region and now it is being recorded from India. From a very closely related species *Lucilla papuensis* Macquart, it is differentiated in having 3 postsutural intra-alars and white thoracic squama while *L. papuensis* has 2 postsutural intra-alars and dark thoracic squama.

Isomyia tibialis (Villeneuve, 1927)

Thelychaeta tibialis (Villeneuve, 1927). *Rev. Zool. Afr.*, **15**: 218. type loc. 'Formosa'.

Strongyloneura viridama Senior-white (nec Tnsd.) 1922. *Mem. Dipt. Agric. Ind. (Ent. Ser.)* 7: 100.

Strongyloneura tibialis (Villeneuve): Senior-White *et al.*, 1940. *FauNa Brit. India, Dipt.*, **6** 167.

Thelychaeta tibialis Villeneuve: Peris, 1952. *An. Aula Dei.*, **3**(1): 182

Isomya tibialis (Villeneuve): James, 1977. *Cat. Dipt. Orient. Reg.*, **3**: 550.

Material examined:

Haryana: Kalka-370M (2♂♂,7♀) 3.X.1999. *Himachal Pradesh:* Solan-1440M (2♂♂)1.X.1999; Kandi-2355M (1♂) 14.IX.2000. Coll. Inderpal Singh Sindhu.

Distribution:

India (Haryana, Himachal Pradesh), Taiwan, China.

Remarks:

Senior-White *et al.* (1940) wrongly identified *Strongyloneura pseudoviridana* as *Strongyloneura tibialis* since both these species show affinities. However, James (1977) assigned the species its correct status. So far this species was known from Taiwan and China. From *Isomyia pseudoviridana* (Peris), it can be separated by the following combination of characters: postsutural acrostichals 2 (3 in *pseudoviridana*), palpi orange (yellow in *pseudoviridana*), propleuron hairy (bare in *pseudoviridana*) and abdomen with irregular dark patches (without dark patches in *pseudoviridana*).

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